INSTRUMENT
INSTRUCTIONS

"S"

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SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, N.Y.

Symbol of Quality

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

Instrument No. 926305

INSTRUCTION MANUAL

FOR

OPERATING AND MAINTENANCE

OF

DIRECT CURRENT MILLIVOLTMETERS

MODEL "S"

TYPE D'Arsonval Double Pivot

ACCURACY .5 of 1%

SCALE LENGTH 6.3"

Symbol of Quality

SENSITIVE RESEARCH
INSTRUMENT CORPORATION
NEW ROCHELLE, NEW YORK.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

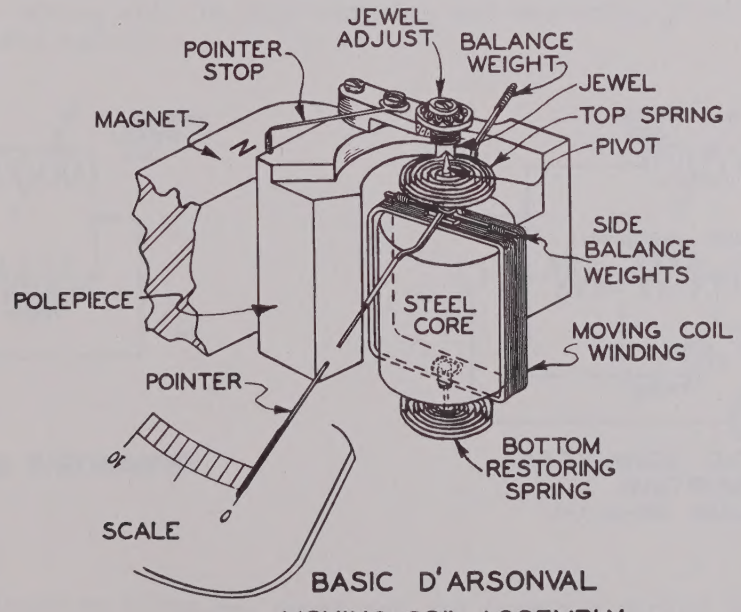
ELECTRICAL MEASURING INSTRUMENTS

D. C. CURRENT MEASUREMENTS

Almost all electrical measurements involve the detection or measurement of an electric current. An electric current can be measured by means of one or more of its physical effects;

1. Heating Effect
2. Chemical Effect
3. Magnetic Effect

Using the magnetic effect caused by a current flow, we can devise an accurate means of measurement. The oldest design of such a device is known as the D'Arsonval Moving Coil System. An elementary sketch of which is shown below.



BASIC D'ARSONVAL MOVING COIL ASSEMBLY

Its operation depends on the force exerted on a current carrying conductor shaped in a coil which is capable of rotation in the field of a permanent magnet.

When a D.C. current flows through this rotatable coil, it creates a field which interacts with the permanent magnet field and produces a torque.

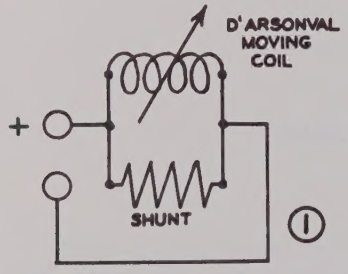
This torque is proportional to the magnet strength, the current in the moving coil, and the number and area of the moving coil turns. The torque produced rotates the mobing coil until its spiral springs are wound up sufficiently to produce an equal and opposite torque. When this point is reached the pointer deflection will be directly proportional to the current which produced it.

Essentially, a D'Arsonval moving coil, which in Sensitive Research Instrument is reactangular in shape, has a steel or diamond pivot at each end which turns in spring mounted jewel bearings.

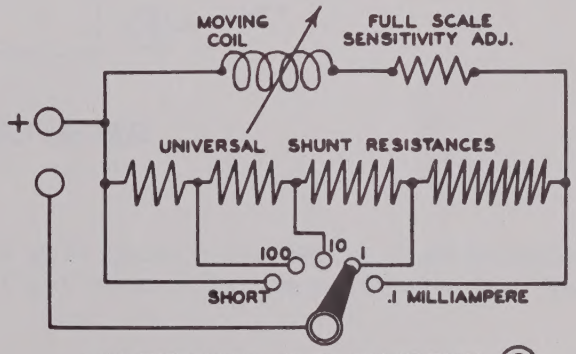
The D.C. current enters and leaves the moving coil usually through spirally constructed phosphor bronze springs which are coiled in opposite directions. These springs also provide the controlling force which opposes the deflecting force created by the current flow through the moving coil turns.

The accuracy of such an assembly to date is superior to any other known type of current deflected mechanism for electrical measuring instruments.

As such a moving coil system will not usually carry over 30 milliamperes without heating errors, we shunt any additional current past the moving coil. By means of calculated and accurately constructed shunts, either single or in a multiple system, we can measure D.C. currents of large magnitude even though the moving coil is only carrying and measuring 30 milliamperes or less. (See circuits below)



SHUNTED INSTRUMENT



MULTIRANGE D.C. CURRENT ② INSTRUMENT
.1-1-10-100 MILLIAMPERES

SENSITIVE RESEARCH has developed and improved during the past 31 years the basic D'Arsonval moving coil system so that today we use it even in our 1/20 of 1% LABORATORY STANDARD D.C. Instruments.

When properly constructed, a D'Arsonval moving coil system will accurately measure very minute D.C. currents as low as .01 of one microampere (.00000001 ampere) and indicate this small magnitude of current by a pointer on an indicating scale drawn in divisions-deflection. This extremely high sensitivity is unusual in portable indicating D.C. Instruments.

D. C. VOLTAGE MEASUREMENTS

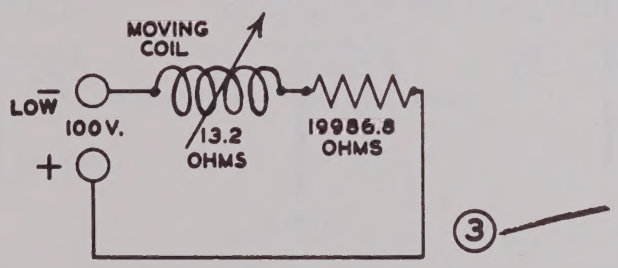
The D'Arsonval moving coil system movement is a current measuring device, but by following a principle of ohms law we can use this current measuring movement to measure D.C. voltage.

FOR EXAMPLE

Assume we wish to measure 100 volts direct current. Also assume that we have a D'Arsonval movement that deflects full scale for 5 milliamperes with a resistance of 13.2 ohms. By Ohms Law, 100 volts across a circuit of 20000 ohms will have a current flow of 5 milliamperes (.005 amperes) by:

$$\frac{100 \text{ Volts}}{.005} = 20000 \text{ Ohms}$$

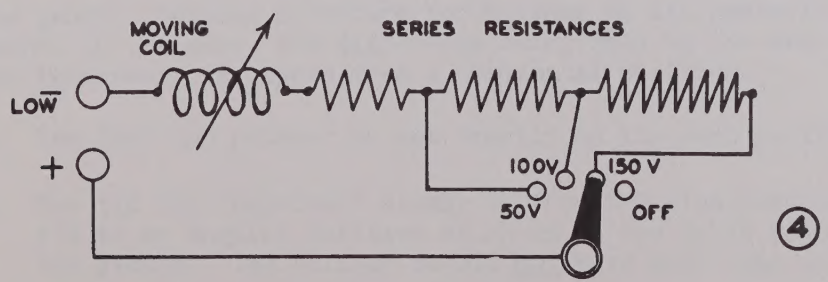
If we place our D'Arsonval moving coil (13.2 ohms) in series with a 19986.8 ohms resistor to equal 20000 ohms;



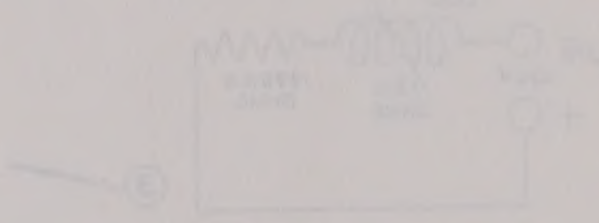
SIMPLE
SINGLE RANGE VOLTMETER
100 VOLTS

Then a potential of 100 D.C. volts will cause a current of 5 milliamperes (.005 ampere). Moving coil pointer deflection can then be calibrated and marked on the scale as 100 volts.

Using the ohms law formula and suitable calculated resistances, we can readily construct multirange D.C. Voltmeters.



MULTIRANGE D.C. VOLTMETER
50-100-150 VOLTS



GENERAL INFORMATION

Upon receipt, your instrument should be carefully unpacked and examined for any visible external damage, i.e; split case, cracked glass, broken binding posts, etc. Place the instrument on a reasonably level bench. If the instrument has a wire shunting (across) the terminals, it should be removed. With the mechanical zero adjuster thumb knob, move the pointer both above and below the zero line of the scale. It should have sufficient travel to go a little beyond zero in each direction. Set the pointer exactly on zero while lightly tapping the instrument case with your fingers. The pointer will be correctly adjusted for zero when no reflection of the pointer's knife edge can be seen in the anti-parrallax mirror and the pointer is directly over and in line with the scale zero.

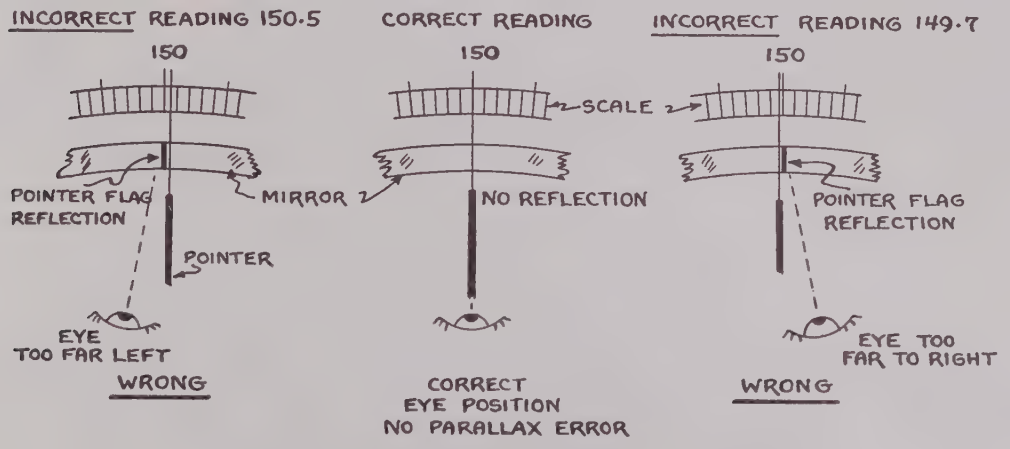


ILLUSTRATION OF THE ANTI-PARALLAX PRINCIPLE

The pointer indication should only be "read" when no reflection of its knife edge can be seen in the mirror below. This is only obtained when the eye is directly over the pointer. The drawings above illustrate the anti-parallax principle.

BALANCE TESTS FOR DIRECT CURRENT INSTRUMENTS

The general testing procedure for balance on all portable and panel instruments is the same, the difference being only in the degree of angle that the instrument is tipped from a horizontal position.

1. See that the pointer is set exactly on its zero position.

2. Now tip the instrument slowly up from the side farthest from you to an angular position as shown on the table below, and tap gently. The pointer should NOT move more than the amount shown on the table below.

3. Next, lay the instrument flat again and then tip it on its side, both left and right, and tap gently.

In both of these procedures, the instrument should be within its balance specifications. In general, these specifications are as follows:

DIRECT CURRENT INSTRUMENTS

MODEL	ACCURACY	ANGLE FROM HORIZONTAL	BALANCE GUARANTEE
UPP PANEL	.5 of 1%	90°	.5 of 1%
UP PANEL	1%	90°	.5 of 1%
J,JW,S, UNIVERSITY PORTABLE	.5 of 1%	25°	.5 of 1%
C PORTABLE	.25 of 1%	25°	.25 of 1%
B LAB. STANDARD	.1 of 1%	10°	.1 of 1%

FRICTION TESTS

The instrument may be tested for mechanical friction at this point, by connecting it to a suitable source of power and deflecting it at least 25% of full scale, then reducing the deflecting current to zero. No instrument should be accepted for use if it has any appreciable friction.

CALIBRATION CHECK

No actual calibration check should be made until the instrument has become thoroughly temperature saturated at ambient room temperatures for at least four hours. (Allowed to reach room temperature.) SENSITIVE RESEARCH calibrates all instruments at exactly 25° C.

Make sure you are on the right range for your power supply. If in doubt set the range switch if any, on the instrument, on its highest range. This will prevent overloading of the instrument when starting any electrical tests. If only a slight pointer deflection results when power is applied, then successively switch the instrument range selector DOWN until a suitable reading is obtained. Bring the pointer up to full scale and open the instrument circuit. A special precaution should be taken by the user of thermocouple instruments, and that is to AVOID opening the primary circuit of a transformer whose secondary circuit is being measured by thermocouple instruments. The reason for this is that the transformer as an energy storing device, may, under certain conditions, DISCHARGE its energy into the secondary circuit, thereby overloading the thermocouple instrument. (Overloads of 1000% are quite possible in transformer circuits.)

This danger can be eliminated by either disconnecting the instrument from the secondary circuit which can be turned to "zero" so that the excitation of any transformer primary may be reduced to "zero" before switching off.

The pointer should return to its original zero without tapping. If it returns to zero only when tapped, it indicates friction in the movement and possible damage to the pivots and jewels, possible through some severe shock in transit. For portable instruments with an overall accuracy of .5 of 1% or higher, and all high torque panel types, the pointer should return to exactly zero. Ultra high sensitivity instruments in the 1% class, and thermocouple instruments in the .75 of 1% class should have a maximum deviation from zero to no more than .1 of 1% of the physical length of the scale.

The pointer should then be deflected using controlled power slowly up and down the instrument scale. The pointer action should be smooth and there should be no sticking or hesitation at any point on the scale. Do not, however, mistake a rough spot in the controls of your power supply for a "stick" in the movement. Often, a badly regulated power supply or a loose circuit connection may make the instrument appear to have an internal variable. All instrument links and leads should be carefully attached and tightened.

The new instrument should be checked against an accurate standard on the cardinal points of the scale. Just one word of CAUTION. Be careful that you do not place your new instrument and your standard too close together, especially with D.C. instruments. They may react magnetically on each other if your standard instrument is not magnetically shielded, it might indicate incorrect readings. Keep them at least six inches apart. Also, if the instrument was specially ordered for use on a steel panel (such information is printed on all our scales) then test it on a steel panel of the specified thickness.

Of all the things, that may be wrong when you get a new instrument, incorrect calibration is the LEAST likely; and if present at all, it will usually be caused by bad balance which you will already have detected by the test just covered. 99.99% of the instruments you receive, if they are satisfactory for balance, friction, stickiness etc., will also be well within their guaranteed accuracy.

NOTE:

Disassembly of the movement should not be attempted unless a skilled instrument man with calibration and scale drawing equipment are available.

CARE AND MAINTENANCE

All SENSITIVE RESEARCH instruments are individually assembled by skilled instrument makers and are INDIVIDUALLY calibrated. We do not calibrate instruments "en masse". Extreme care has been used in selecting pivots and shock mounted jewel bearings. In some instruments DIAMOND PIVOTS are used.

The instrument should be used and treated as a precision standard. A reasonable amount of care will bring its reward in a lifetime of accurate service.

Good practice dictates that periodic checks be made for pivot friction, coil, balance, scale calibration, and the mechanical integrity of any instrument.

If the instrument glass is cleaned by any method, the task should be completed by heavily breathing upon the glass so as to dissipate any electrostatic charges that may have been generated by friction. Occasionally the binding posts metal contact surfaces should be cleaned and brightened by the careful use of a fine sandpaper. A yearly coat of wax on any wooden instrument case is suggested.

Instrument panels are cleaned by using carbon tetrochloride to dissolve any greasy surface accumulations. A brisk rubbing with a soft flannel cloth will restore our moulded panels to their original lustre. Should the engraving "white" become discolored it can be removed with a sharp point and refilled with a white wax crayon material obtained from us.

OPERATICNAL PROCEDURE

1. Place the instrument on a level surface so that the scale is horizontal. Deviations of more than 5° from the horizontal may affect accuracy adversely.

2. For good instrument practice, the instrument should be kept away from any source of very strong magnetic fields. Maximum tolerable field is 5 oersted.

3. Set the pointer on zero by rotating the zero shifter, using thumb or zero screw. The pointer is correctly set on zero when the reflection of the pointer in the antiparallax mirror coincides with the pointer itself and with the zero line. (See general information sheets.) Page 4

4. For safety it is best to turn off the current or voltage to be measured before making connections to any instrument. Observing proper polarity, connect the instrument terminals in series with the circuit if current is to be measured.

   If voltage is to be measured then the voltmeter is to be in parallel to the portion of the circuit desired. It is important to remember that when an ammeter (current measuring instrument) is inserted in series with a circuit, the circuit is changed by the introduction of the ammeter resistance. Ammeters are therefore designed to be of low resistance so that they will only be a small fraction of the total resistance of a circuit.

   Remember also that when a voltmeter is connected across (in parallel) with a portion of a circuit it changes the potential difference by its own effect on the circuit and since it also is connected in parallel with a part of the circuit it reduces the effective resistance of that portion which increases in some degree the total current flowing in the complete circuit.

   Therefore voltmeters are designed to have the highest resistance possible so as not to change materially any circuit to which they may be applied.

5. It is considered good instrument practice in multirange instruments to have the range switch on the highest possible range and then the user can progressively switch down to the range that produces an acceptable reading. A good acceptable reading would be one in which the pointer is indicating in the upper fifth of the scale. (Nearly maximum deflection.) Apply power and observe pointer deflection. When the instrument pointer has come to rest, the current is indicated by the position of the pointer on the scale.

6. After the desired measurements have completed, turn off the current supply and disconnect the instrument terminals from the source of current. If the instrument leads are left connected and circuit changes made damage could result to the instrument being on a range setting lower than the newly applied power value.

SENSITIVE RESEARCH INSTRUMENTS have a data card attached to it or mounted in its case. This data card detailing the accuracy and electrical characteristics together with the instrument panel engraving will readily enable the user to operate our instruments to their full accuracy and their personal satisfaction.

INST. NO 926.304

SENSITIVE RESEARCH INSTRUMENT CORPORATION 310 MAIN STREET, NEW ROCHELLE, N. Y.	
MODEL: "S" RANGES: 5-20-50-100-500 MV.	
DATE: 12-19-60	SCALE: NONE
DESIGNER:	DRAFTSMAN: T.D.T.
APPROVED:	DRN. NO.:

LABORATORY STANDARDS

DIRECT CURRENT

MICROAMMETERS	INCREMETERS	MILLIAMMETERS
AMMETERS	MILLIVOLTMETERS	VOLTMETERS

Self-checking
D.C. LABORATORY STANDARD

Self-checking
A.C. & D.C. LABORATORY STANDARD

ALTERNATING CURRENT

MILLIAMMETERS	VOLTMETERS
AMMETERS	WATTMETERS

MODELS

BS	B	DYL
STC	L	INCRE
THACH	LW	CHC
	STV	

Symbol of Quality

SENSITIVE RESEARCH INSTRUMENT CORPORATION
NEW ROCHELLE, NEW YORK.

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

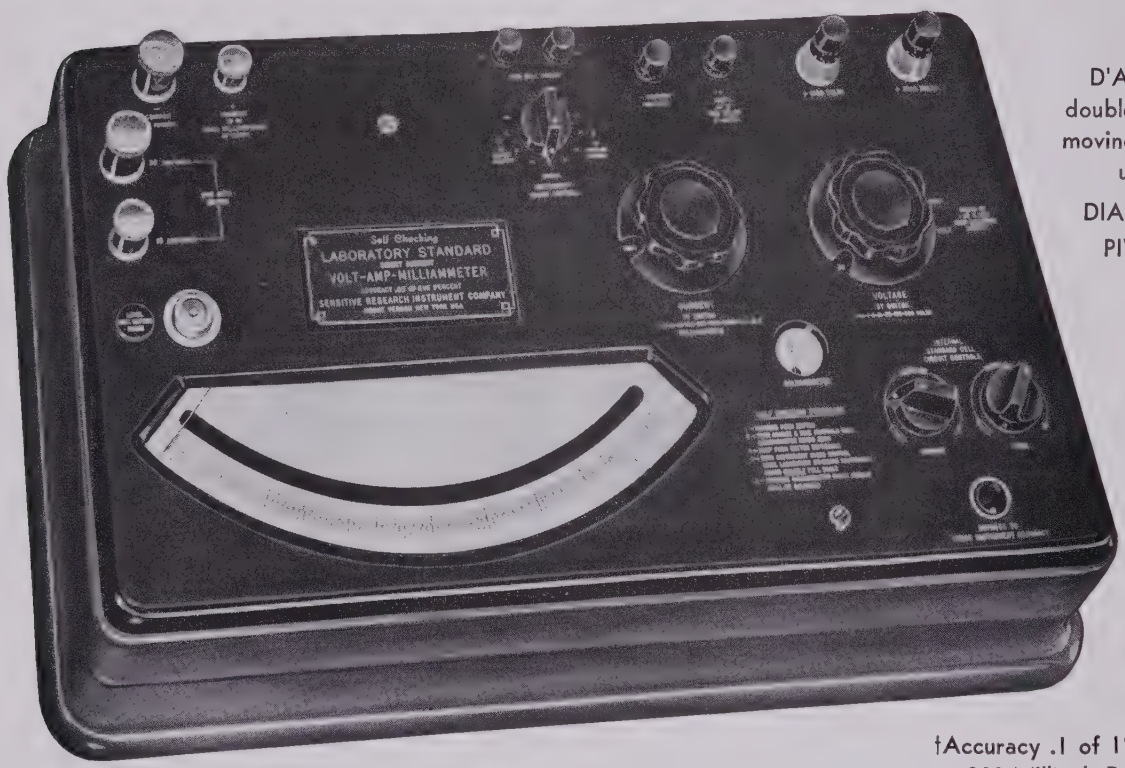
DIRECT CURRENT LABORATORY STANDARD

MODEL **BS**

*SELF CHECKING!

MEASURES WITH AN
ACCURACY OF .05 OF ONE PER CENT
1.5 MILLIAMPERE to 15 AMPERES
LOWEST SCALE DIVISION 15 MICROAMPERES

†300 MILLIVOLTS to 1500 VOLTS
LOWEST SCALE DIVISION 3 MILLIVOLTS



D'Arsonval double pivoted moving element using DIAMOND PIVOTS

†Accuracy .1 of 1% on 300 Millivolt Range only

12 INCH VERNIER SCALE

The Model BS represents one of the most advanced steps in precision instrument design in many years. Its unusual accuracy of .05 of 1% (1/20 of 1%) is double that of any laboratory standard instrument heretofore available . . . PLUS . . . the fact that it CHECKS ITS OWN ACCURACY!

The user of this DC Laboratory Standard can always be assured that he possesses an unusual instrument with the utmost in stability that has ALL the accuracy anyone can read.

Basically, the instrument is a 25 range, precision built DC standard, that covers a wide area of measurements in one self-contained unit. The scale is hand drawn on a special SRIC machine and its divisions are mechanically placed within .005 inch. This produces an instrument that will read within, plus or minus, 1/20 of 1%.

We use "*Diamond Pivots*" and shock mounted jewels exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. These pivots reduce the friction to a completely negligible level. Diamond pivots will withstand the tremendous impact of a three foot drop without deformation to either pivot or jewel.

To check and MAINTAIN .05% accuracy, we have designed an internal potentiometer circuit with its own internal standard cell and sensitive galvanometer.

Its operation is simple. By turning a switch knob on the panel and adjusting two rheostats until the galvanometer reads zero, a standard current is caused to flow through the instrument which then deflects full scale. This check can be made even though there is current or voltage through the instrument. However it is considered good instrument practice to disconnect any external circuit which might change its values while certifying the instrument.

* Copyright 1951

SELF CHECKING D.C. LABORATORY STANDARD VOLT-AMP-MILLIAMMETER

MODEL BS

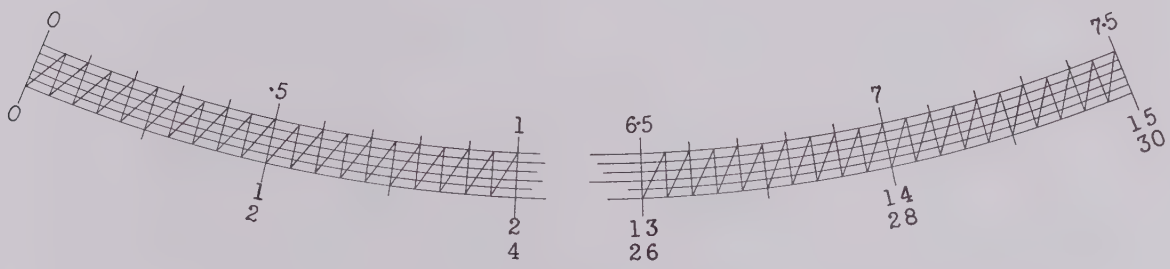
The small dry cell which supplies the standardizing current is a Mallory-Mercury A (No. RM-12 blue label) product, available almost everywhere. It can be replaced in a few moments.

The Standard cell can also be replaced readily by the user from the bottom of the case. Replacement standard cells are available with a statement of their absolute voltage.

The use of the self-checking feature in the Model BS eliminates all temperature coefficients between 20°C and 30°C. In addition, the instrument's accuracy is unaffected by the presence of external magnetic fields. These very excellent performance characteristics are possible because the operator is able to continuously adjust and check the basic sensitivity of the instrument. The temperature coefficient of the standard cell is negligible through a wide range of room temperatures, (—.00001 volt per 1°C). The Standard Cell is mounted in an internally insulated case to reduce any possible temperature changes.

The instrument is electrostatically shielded. The panel glass has a clear conducting surface on its underside which prevents static charges from accumulating on its surfaces.

The user of this instrument has a very complete direct current testing standard at his disposal. It covers the range of thousands of dollars of associated equipment. Measurements may be made in current and voltage many times faster because both a primary current standard and a highly accurate precision indicator are all compactly arranged in this one self checking instrument.



SECTIONAL FULL SIZE PRECISION VERNIER OF 12 INCH SCALE

External ranges are available in current, if desired, using external shunts in conjunction with the 300 millivolt range of the instrument. External current shunts (300 millivolt drop) are listed on Shunt page, see index.

The voltage ranges of the instrument may be readily extended by the use of external 1000 ohm per volt multipliers. For instance, to measure 7500 volts DC, a precision 6,000,000 ohm resistance should be connected in series with the 1500 volt post. For a description of the standard voltage multipliers available see catalog index.

The instrument is mounted in a beautiful walnut case with removable dust cover. The top surface is of highly polished black insulation. The size, when covered, is 24" x 14" x 8", weight 34 lbs.

The Model BS is unconditionally guaranteed for workmanship and materials.

	Full Scale Values	Code	Price
Current	1.5/3/7.5/15/30/75/150/300/750 M.A. & 1.5/3/7.5/15 Amperes	SELFCHECK	
Voltage	.3/.75/1.5/3/7.5/15/30/75/150/300/750/1500 Volts	(Supplied with Dust Cover)	$1825.00
	Replacement standard cells with necessary standard resistance		50.00

DIRECT CURRENT "VOLTAGE STANDARD"

Type A

MODEL STV

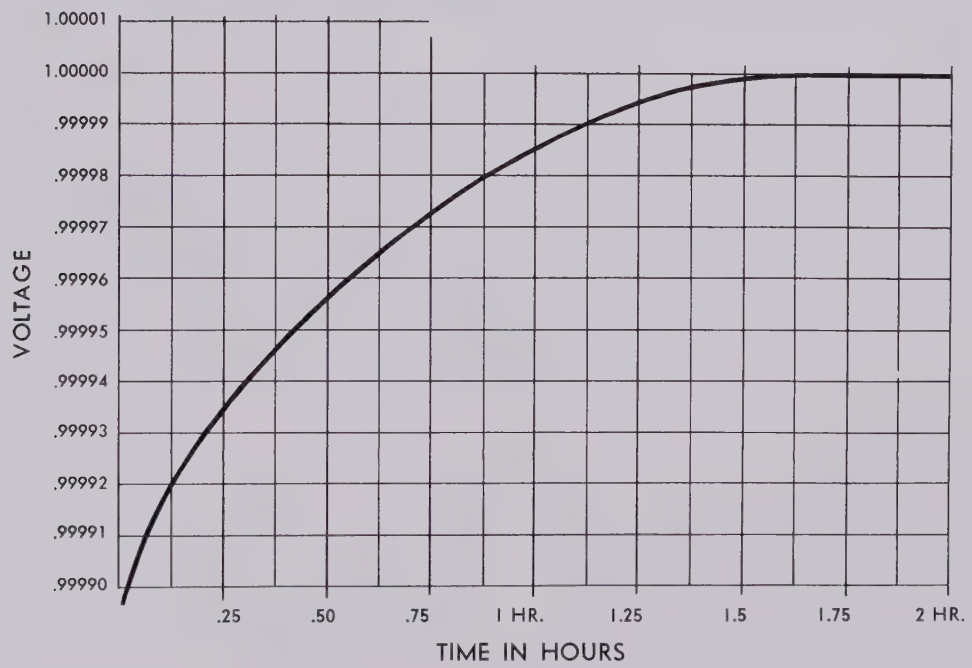
ACCURACY ±.01%

STABILITY ±.005%

This instrument is supplied in a hand rubbed walnut case, with an engraved black insulated top panel. Size of unit is 9 3/8" x 7 5/8" x 5" — weight is 10 lbs.

Its operation is quite simple. Plug in to a 115 volt — 60 cycle line and the unit is ready for use. If extreme accuracy is required, a waiting time of two hours is necessary. It is also suggested that this unit be run continuously if possible.

TYPICAL CURVE SHOWING VOLTAGE VARIATION WITH TIME



SPECIFICATIONS

Type A

INPUT REQUIRED: 90 - 135 volts — 60 cycles — 25 va.

OUTPUT: 1.0000 volt and 1.0185 volts (within .01% of nominal value)

ACCURACY: .01

STABILITY: ±.005% of measured value for an input of 100 - 125 volts and 20° - 30°C. 90-135

±.01% of measured value for an input of 90 - 140 volts and 15° - 35°C.

Code	Price
	$280.00
STVALV	

Type B

Rack Panel Mounting version of Type A on 19" x 5 1/4" x 5/16" bakelite panel

ACCURACY:

STABILITY: SAME AS CODE STVALV ABOVE

Code	Price
	$295.00
STAVAPM	

Output voltages are measured to an accuracy of ±.001% and are given in a certificate furnished with the Model STV.

DIRECT CURRENT "VOLTAGE STANDARD"

MODEL STV

The Sensitive Research "Voltage Standard," the Model STV, is an extremely accurate voltage source. It is designed to furnish voltages of 1.0000 volt and 1.0185 volts for use as a reference for all types of "null balance" devices such as potentiometers and similar infinite impedance comparators. It will operate with complete freedom from the long term drift characteristics which are inherent in the usual unsaturated type of standard cell.

The accuracy of the Model STV is between that of the laboratory type unsaturated standard cell and the highly precise, temperature stabilized, saturated standard cell.

Its output is fully accurate only into an infinite impedance load (zero current drain). However it can be operated without damage into any impedance. In those cases of "off balance" where it is necessary to draw current, the unit will supply this current for an unlimited time without affecting its accuracy. After being shorted for long periods of time it will IMMEDIATELY resume its original open circuit voltage when the short is removed.

By way of definition, the term "nominal values" as used in this literature refers to the values of 1.0000 and 1.0185 engraved on the instrument.

All units are adjusted to within .01% of the nominal values of 1.0000 and 1.0185 volts as engraved on the panel. The exact values of the individual units are measured and stated in the accuracy certificate to an accuracy of .001% at 25° C and 115 volt line voltage after a two hour warm up period. The long term stability (periods of 6 mos.) of this measured value is ±.005% including variations with line voltages from 90 to 135 volts and temperature variations of 20° to 30° C.

The Model STV is substantially free of temperature errors within the limits of 15 degrees C. to 35 degrees C. and hence does not require temperature baths as do the saturated type of standard cells. It is free of position influence (which plagues both types of standard cells) and can therefore, be mounted and used in any position, provided a free circulation of air around the case is allowed. *It cannot be damaged by overloading or even short circuiting.* As a matter of fact, it can be SHORT CIRCUITED INDEFINITELY without affecting either its accuracy or its life expectancy. Recovery of the Model STV is almost instantaneous after the short circuit is opened.

Two output voltages are available. A voltage of 1.0185 volts is provided so that it may be easily substituted in place of a standard cell. A voltage of 1.0000 volt is also provided for the extra convenience of those working with reference circuits in which an even value simplifies calibration procedures. These nominal voltages are adjusted to within .01%.

The ability of this voltage standard unit to operate under short circuit conditions has many advantages over the usual standard cell. Few people realize the possibilities of incorrect readings from operating errors in the use of potentiometric measurements and similar galvanometer "null balance" operations involving standard cells. The inadvertent pressing of the "fine" balance key when the potentiometer is far off balance will result in a current drain from a standard cell sufficient to cause it to give incorrect readings for as much as several hours. Possibility of this type of error is completely eliminated when the Model STV is substituted for a standard cell.

The accuracy of the Model STV is maintained in spite of severe handling during transportation. The usual requirement of having to wait several hours after transporting a standard cell before the readings have settled down is eliminated.

The two output voltages are not available simultaneously except under completely open circuit conditions. The input supply required is 90 - 135 volts at 60 cycles and the unit draws approximately 25 VA. Ambient temperatures of 15 to 35 deg. C. will influence the output voltage less than .01%. There is an initial slight drift of less than .01% (of actual measured values, NOT of nominal value) during its warm up period. A certificate is given with each instrument. This shows the exact value of output voltage to a measured accuracy of .001% with 115 volts input after 2 hours operation at an ambient temperature of 25° C.

Special units are available for any designated voltage up to 7.5 volts and can be furnished to deliver up to .5 ma. into specified external resistances.

Self Checking

MODEL **THACH**

MULTICHEK DESIGN

FOR POWER SUPPLY SEE PAGE 58

Standard VOLT-AMP-MILLIAMMETER

AC – DC

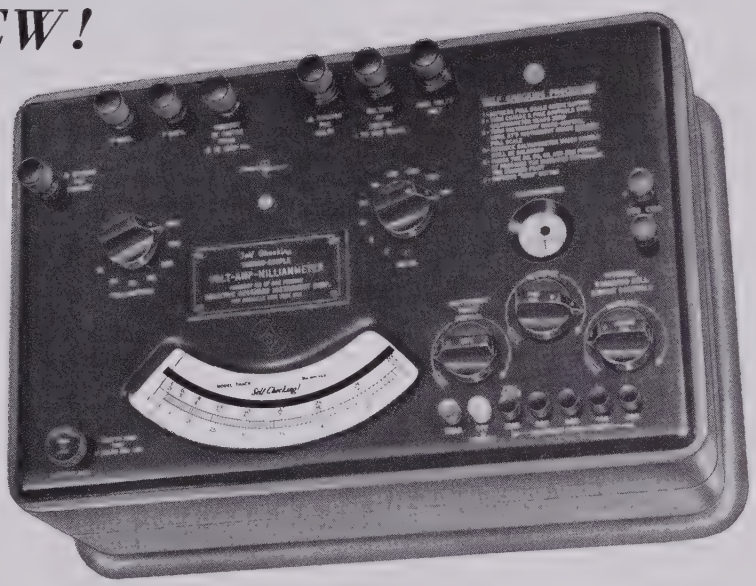
NEW!

ACCURACY

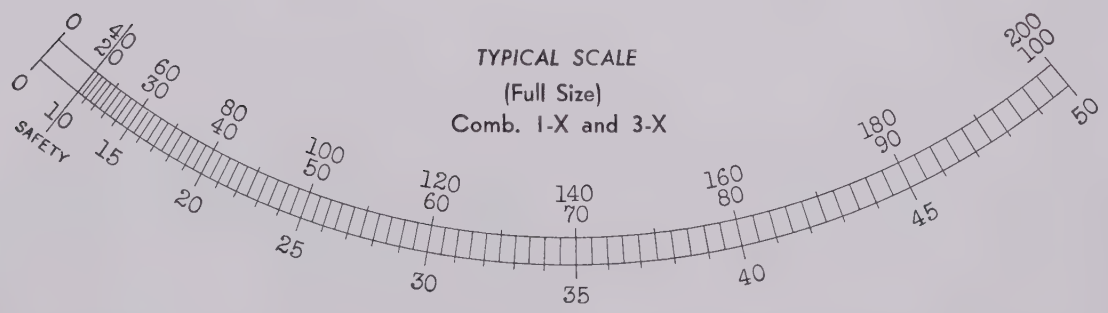
.2 of 1% DC to 4000 Cycles

.1 of 1% DC to 4000 Cycles
(at Multicheck Points)

Above 4000 Cycles Accuracy is 1% to 15,000 Cycles



DOUBLE PIVOTED MOVING COIL SYSTEM USING DIAMOND PIVOTS!



TYPICAL SCALE
(Full Size)
Comb. 1-X and 3-X

The "MULTICHEK" version of our standard Model THACH, we believe, offers a number of significant advantages over the original instruments which are still available if desired.

Users of our Model THACH have long been aware of the fact that the top point (full scale) values of the THACH instrument were markedly higher in accuracy than the actual instrument guaranteed accuracy. This is usual in the traditional conservatism of the SRIC accuracy guarantees. The built-in Self-Check feature readily allows the user to standardize the full scale point in terms of the internal standard cell to an accuracy of .1% or better. The actual .2% figure in the accuracy is to allow for possible scale characteristic changes in the thermocouple due to slight overloads. These changes would cause very small errors at other portions of the scale even though the full scale point is readjusted to exact values by the full scale Self-Check feature.

MULTICHEK DESIGN

This new "MULTICHEK" design has the Self-Check feature with push button switching to allow standardization at FOUR ADDITIONAL POINTS on the scale. Standardizing can be rapidly accomplished at full scale, 80% of full scale, 60% of full scale, 40% of full scale and 20% of full scale. Checks at these points will show up any minute thermocouple variations and by choosing the nearest of the check points to the point of use for standardization, these variations can be minimized. The normal usage of the "MULTICHEK" feature is to standardize at full scale as in the usual THACH operation. A quick check is then to be made at each of the lower standardizing points to be assured of couple characteristics being unchanged. In the event that the couple has been slightly changed by abuse it is then possible to still get extremely accurate readings by restandardizing at the check point nearest the scale reading which is to be used.

The traditionally fine features of our standard Model THACH, such as its wide frequency response, true RMS readings, low circuit loading are all retained in the new "MULTICHEK" models. In addition, the THACH "MULTICHEK" will allow obtaining the absolute ultimate in accuracy from a thermocouple type of instrument. No normal operating characteristics are sacrificed in applying these additional check points to the instrument. The obtaining of the various scale points for standardization is very markedly facilitated by the use of a very high quality push button type switch. The push buttons are color coded and engraved for extremely rapid operation and their switching contacts have been tested in many thousands of operations.

The instrument is used in every manner similar to our standard Model THACH. The "FULL SCALE CHECK" Push Button is pressed and the "coarse" and "fine" rheostats adjusted to bring the galvanometer to zero. This standardizes a full scale current value. If the main instrument scale reads other than EXACTLY full scale it is corrected to the EXACT full scale point by means of the "MICRO CONTROL." The 80%, 60%, 40% and 20% points can then be checked by depressing the appropriate buttons and making slight current readjustments, if necessary, to bring the galvanometer to zero for each point. These points will normally show exact agreement with the pointer positions, but if slight errors are encountered the "MICRO CONTROL" can be readjusted at the check point nearest to the reading to be taken and the error thus minimized to an accuracy of .1 of 1%.

The use of the MULTICHEK feature eliminates all temperature coefficients in the instrument which would normally affect instrument accuracy.

This new model *MULTICHEK* THACH will prove a very worthwhile addition to any active standardizing laboratory.

SELF CHECKING
AC-DC STANDARD VOLT-AMP-MILLIAMMETER
NEW MULTICHEK DESIGN

TYPE: Thermocouple — D'Arsonval. DIAMOND-PIVOTS and shock mounted jewels included.

ACCURACY: .2 of 1% throughout range—.1% at the "MULTICHEK" points.
DC to 4000 cycles, 1% to 15,000 cycles.

SCALE: 6.3 inches, hand-drawn, mirrored scale.

SENSITIVITY: 100 ohms per volt.

DIMENSIONS: Approx. 16⅜ x 10½ x 8¾ inches.

WEIGHT: 21 lbs. Shipping weight 43 lbs.

NOTE: Comb. 3-X: 2 & 5 ampere and 1000 volt ranges .2 of 1% accurate to 2.5 kc. 1% to 10 kc.
Comb. 4-X: 1.5 & 3 ampere and 750 volt ranges .2 of 1% accurate to 2.5 kc. 1% to 10 kc.

Combination 3-X

	Full Scale Ranges	Code		Price
Current	0—10/20/50/100/200/500/1000 m.a./2/5 amperes	MULTILAB	(Standard Model) single thermocouple	$1175.00
Volts	0—1/2/5/10/20/50/100/200/500/1000 volts	DEMULTILAB	(DELUXE MODEL) two thermocouples	$1375.00

Combination 4-X

	Full Scale Ranges	Code		Price
Current	0—15/30/75/150/300/750 m.a. & 1.5/3 amperes	MULTISELF	(Standard Model) single thermocouple	$1075.00
Volts	0—1.5/3/7.5/15/30/75/150/300/750 volts	DEMULTISELF	(DELUXE MODEL) two thermocouples	$1275.00

(Both of above supplied with dust cover)

Replacement standard cell with necessary resistance and statement of its absolute voltage ..... each $ 45.00
Replacement thermocouple with correction curves for reading the instrument to its original accuracy ..... each $ 75.00
Replacement thermocouples without deviation curves and guaranteed to original accuracy of instrument ..... each $100.00

Due to the extreme accuracy involved, replacement thermocouples can be supplied ONLY when the instrument, itself, is IN THE FACTORY.

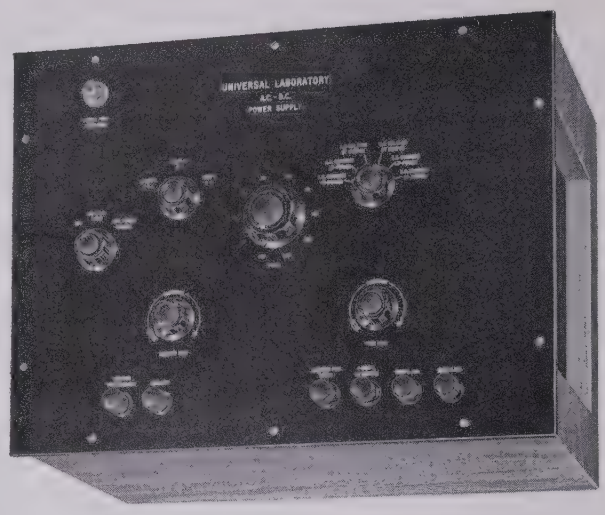
POWER SUPPLY FOR THACH

The "SENSITIVE RESEARCH" THACH POWER SUPPLY is an accessory designed to make the popular THACH AC - DC Laboratory Standard instrument into a versatile current and voltage calibrator.

This power supply is specifically designed with instrument calibration use in mind. The operating controls are such that extremely fine adjustment of voltages or currents can be had regardless of the range in use. The precision of adjustment is equally as good on the 1 volt range as it is on the 1000 volt range. In each case a fine and a coarse control give a resolution of at least .05% at any point on the instrument scale. This is a virtual necessity if really high accuracy is to be obtained in certification work.

In addition there is a built-in protective system which will eliminate most of the possibilities of thermocouple burnout in the THACH instrument. An automatic relay system shuts off the power from the supply when ANY range switch is changed. In order to reactivate the system it is necessary to return the coarse control to zero and start over in bringing up the power. This will prevent the major portion of the burnout difficulties which arise from inadvertently changing a range of the instrument.

This interlock works when any range switch on the power supply is changed. Also provision is made to include shut down for any range change on the THACH instrument. This requires a modification of the THACH instrument and such modified instruments are in no way affected for normal operation. If the connecting cable between instrument and power supply is removed, both instrument and power supply can be used independently.



MODEL THACH-PS

The power supply will furnish regulated AC voltages at 60 cycles or DC for all of the voltage and current ranges of the THACH instrument. In addition the supply can be fed from any 115 volt power at frequencies from 50 to 2500 cycles and furnish the same controls for all ranges of the instrument. In operation at frequencies other than 60 cycles, no additional regulation is supplied over that of the line feeding the supply.

In addition to being an ideal complement to the THACH instrument this supply is a very excellent general purpose standardizing laboratory supply. The extremely precise control over the entire range of operation is a marked advantage for any calibration work.

SPECIFICATIONS

Output: AC or DC output selected by switch.

10 voltage ranges each with coarse and fine controls for 0 to 120% at full load and delivering a maximum of 175% at no load.

1, 2 or 5 volts at 300 ma.
10, 20 or 50 volts at 100 ma.
100, 200, 500 or 1000 volts at 25 ma.

Two current ranges (selected by switch) supply 0 - 5 A. at 15 watts maximum on low power position or 75 watts maximum on the high power.

Input: 90 - 135 volts, 60 cycle single phase, or 115 volts AC 50 to 2500 cycles from a regulated source.

Ripple: 2½% maximum for currents of 1 ampere or less. 7% RMS maximum for currents above 1 amp. (This can be reduced to 3% in all cases by simple series resistance added to meter being calibrated.)

Waveform: 60 cycle distortion 2½% total harmonic content plus line distortion.

Safety Interlock: Safety interlock on all internal switches to shut off power when supply range is changed. The model THACH is connected to the power supply by means of a cable which we supply so that the THACH switches are included in the safety interlock circuit. (THACH must be ordered with interlock or modified at the factory.)

Dimensions: 12¾" x 17" x 9" **Weight:** Approx. 59 lbs. **Code:** THAPOS **Price:** $995.00

THACH modification for interlocking use with this supply, $100.00 at time of original order. If added to existing instruments in the field the cost is $200.00

*Self Checking!

MODEL **THACH**

FOR POWER SUPPLY
SEE PAGE 58

THERMOCOUPLE TYPE

Double pivoted moving element using DIAMOND PIVOTS

Made in Two Range Combinations

ACCURACY .2 OF 1% DC TO 4000 CYCLES

FOR USE ON AC or DC 1% UP TO 15,000 CYCLES

DELUXE MODEL PICTURED
19 SELF CONTAINED RANGES

This new self-checking AC/DC standard enables a laboratory, without expensive potentiometers and transfer standards, to measure with confidence, a large range of currents and voltages at frequencies from 20 to 15,000 cycles.

This *REALLY* new instrument will measure much *MORE* than any AC/DC instrument available today and with its self-checking feature will certify its own accuracy. Temperature corrections are not necessary within 20°C to 30°C.

This new instrument represents a very advanced step in modern instrument design. Its accuracy of .2 of 1% is more than double that of the usual thermocouple instrument—PLUS the fact that *"IT CHECKS ITS OWN ACCURACY"!*

Basically, the instrument is a completely self contained, precision built D'Arsonval D.C. movement and circuit which measures the current output of a thermocouple. On our DeLuxe models we use two matched thermocouples with the necessary switching (see picture). The vacuum thermocouple is used in very stable resistance circuits whose values are adjusted to maintain a resistance accuracy of better than $\frac{1}{20}$th of 1%.

The instrument scale is 6.3 inches long and is hand drawn on a hard white enamel surface. The scale graduations are precision positioned within an accuracy of .005 inch.

We use *"Diamond Pivots"* and shock mounted jewels exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. These pivots reduce the friction to a completely negligible level. Diamond pivots will withstand the tremendous impact of a three foot drop without deformation to either the pivot or jewel.

The instrument is electrostatically shielded. The panel glass has a clear conducting surface on its underside which prevents static charges from accumulating on its surface.

To maintain the instrument's overall accuracy of .2 of 1%, we have designed an internal potentiometer circuit with its own internal standard cell and sensitive galvanometer.

*Copyright 1951.

A.C.-D.C. STANDARD VOLT-AMP-MILLIAMMETER

MODEL THACH

SELF CHECKING PROCEDURE

Its operation is very simple. By moving a knob on the panel to its "check" position and adjusting two rheostats until the internal galvanometer reads zero, a standard current is caused to flow through the instrument which then deflects full scale.

IF, however, it is slightly off full scale, then a micro adjustment knob is turned UNTIL the instrument reads FULL SCALE. This means that we have now certi fied the full scale reading of the instrument in terms of an EXACT current which has been standardized by an internal potentiometer standard cell circuit, the galvanometer still keeping a "zero" balance all the time.

As the scale has been very accurately drawn, the instrument is now checking within .2 of 1% over its entire scale and the top full scale point is EXACTLY CORRECT. This check can be made even though there is current or voltage in the instrument, although this is not recommended as good instrument practice.

It is so designed that the certified voltage of the standard cell can be checked externally, if desired. The standard cell can be readily removed or replaced without opening the instrument case. (See instructions accompanying the instrument.)

Our DELUXE Models have two identical independent internal vacuum thermocouples and either can be used as desired.

If extra matched thermocouples are supplied at the time of original purchase of the instrument, they can be readily replaced by the user by removing a plate on the bottom of the case.

We have found it difficult to select thermocouples which will check original calibrations at the close tolerance of .2 of 1% from later stocks. It will therefore be necessary to return the instrument to us for replacement of thermocouples and possible recalibration if necessary UNLESS spare themocouples are ordered from us WHILE THE INSTRUMENT IS IN OUR POSSESSION.

TYPE: Thermocouple — D'Arsonval. DIAMOND PIVOTS. and shock mounted jewels included.

ACCURACY: .2 of 1% of full scale.
DC to 4000 cycles, 1% to 15,000 cycles.

SCALE: 6.3 inches, hand-drawn, mirrored scale

SENSITIVITY: 100 ohms per volt.

DIMENSIONS: Approx. 16⅜ x 10½ x 8¾ inches.

WEIGHT: 21 lbs. Shipping weight approx. 43 lbs.

COMBINATION 1-X

Code	Price
CHEKALAB (Standard Model) single thermocouple	$975.00
DELABACHEK (DELUXE MODEL) two thermocouples	1075.00

CURRENT

Full Scale Values	Range Resistance
10 milliamperes	30 ohms
20 milliamperes	37.5 ohms
50 milliamperes	20.4 ohms
100 milliamperes	11.1 ohms
200 milliamperes	5.8 ohms
500 milliamperes	2.4 ohms
1000 milliamperes	1.2 ohms
*2 amperes	.5 ohm
*5 amperes	.24 ohm

VOLTAGE

1 volt	100 ohms
2 volts	200 ohms
5 volts	500 ohms
10 volts	1000 ohms
20 volts	2000 ohms
50 volts	5000 ohm
100 volts	10000 ohms
200 volts	20000 ohms
500 volts	50000 ohms
*1000 volts	100000 ohms

COMBINATION 2-X

Code	Price
ACCURCHEK (Standard Model) single thermocouple	$875.00
ACCURMETER (DELUXE MODEL) two thermocouples	975.00

CURRENT

Full Scale Values	Range Resistance
15 milliamperes	40 ohms
30 milliamperes	30 ohms
75 milliamperes	14.4 ohms
150 milliamperes	7.6 ohms
300 milliamperes	3.9 ohms
750 milliamperes	1.58 ohms
*1.5 amperes	.79 ohm
* 3 amperes	.39 ohm

VOLTAGE

1.5 volts	150 ohms
3 volts	300 ohms
7.5 volts	750 ohms
15 volt	1500 ohms
30 volts	3000 ohms
75 volts	7500 ohms
150 volts	15000 ohms
300 volts	30000 ohms
*750 volts	75000 ohms

LOWEST POSSIBLE READING IS 1/5 OF FULL SCALE

Replacement standard cell with necessary resistance and statement of its absolute voltage	each $ 45.00
Replacement thermocouple with correction curves for reading the instrument to its original accuracy	each $ 75.00
Replacement thermocouples without deviation curves and guaranteed to original accuracy of instrument	each $100.00

Due to the extreme accuracy involved, replacement thermocouples can be supplied ONLY when the instrument, itself, is IN THE FACTORY.

The instrument is mounted in a beautiful walnut case with dust cover.. The top surface is of highly polished moulded black bakelite. The size, when covered, is 16⅜" x 10½" x 8¾", weight 21 lbs.

* .2% to 2500 cycles 1% to 10,000 cycles

THERMO-COUPLE PROTECTION

To date it has not been found practical to protect a VACUUM THERMO-COUPLE by any method of fusing, due to the high resistance that low current capacity fuses insert in the instrument circuit. Therefore, we use a protective device, developed by ourselves, which will protect the Thermo-Couples in the instrument up to 1000% overload. Thermo-Couples without protection will just about withstand 100% overload.

Briefly explained, it consists of a finger-operated push button mounted on the left panel surface, correctly adjusted shunts and a red safety line drawn on the instrument scale. When the safety is on, it shunts 4/5 of any applied current around the heater of the Thermo-Couple. Normal heater current will then only give a scale deflection of 1/5 of full scale.

At this point on the instrument scale, a red line is drawn marked "Safety." Therefore IF when the instrument is put on test, the pointer reads ABOVE the red line, it indicates that the instrument is being OVERLOADED. Current or voltage should therefore be reduced until pointer reads BELOW red line. Button is then depressed and the instrument reads the actual current or voltage. This button can be locked in its "use position".

The Safety Shunt is so compensated that its operation DOES NOT change the instrument resistance or AFFECT any external circuit. The addition of this feature very materially reduces the upkeep cost of instruments, which is an item in any laboratory.

MODEL THACH

The small dry cells, (Mallory Mercury "A" Size D) which supply the standardizing current, are available everywhere or from us and they are readily replaced in a few moments from the bottom of the case.

The instrument is supplied complete with all operating instructions. If desired, any range can be checked by the user on Direct Current. Like all our Thermo-Couple instruments, it will measure D.C. as readily as A.C. without taking reverse readings. We suggest using a precision potentiometer and "ABS" standards as the instrument is calibrated in the absolute system.

By these methods, the user is assured of the instrument's accuracy at all times and at all the usual room temperatures. The use of its SELF-CHECKING feature, eliminates all temperature coefficients in the instrument between 20°C and 30°C that would usually affect instrument accuracy. The temperature coefficient of the standard cell is negligible through a wide range of room temperatures (—.00001 volt per 1°C), and it is mounted in an internally insulated bakelite case to reduce any unusual temperature changes.

The standard cell should not be exposed to extremes of temperature. It is recommended that it be kept between 4°C. and 40°C. to insure its long term stability. It too is readily replaced from the bottom of the case.

The user of this instrument has a very complete alternating current testing standard at his disposal. It covers the range of many thousands of dollars of associated equipment. Measurements may be made in current and voltage many times faster, all compactly arranged in this one instrument.

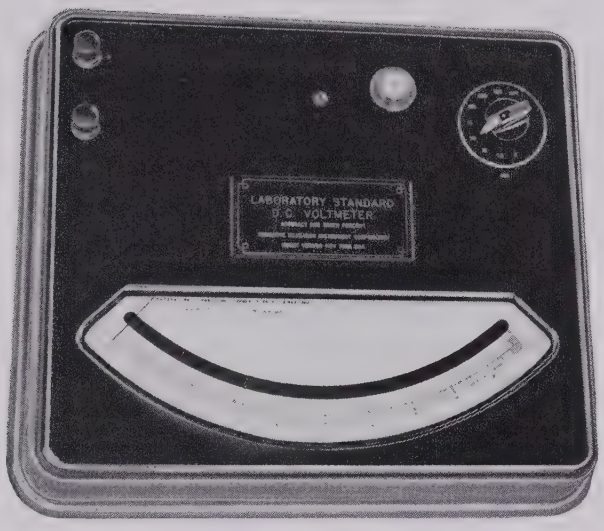
On voltage, measurements can be made above 1000 volts using external 100 ohm per volt multipliers. For instance, to measure 10,000 volts AC, connect a precision 900,000 ohm resistance, (10 MA rating), in series with the 1000 volt post and read 10,000 volts on the 100 scale. External voltage multipliers are available. See index.

The extended frequency ranges of this instrument represent a major achievement in design. From a standpoint of stability, only wire wound resistances can be tolerated in a .2 of 1% accuracy instrument. The design of these resistances, to such a low degree of residual reactance as to allow .2 of 1% accuracy from DC to 4000 cycles is a noteworthy accomplishment. The frequency variation increases gradually to a little less than 1% error at 15,000 cycles and the instrument can be used even at somewhat higher frequencies at reduced accuracy. This extended coverage is achieved by careful attention to phase angles in all portions of the instrument and the use of high frequency vacuum thermo couples.

Due to the high accuracy and precision of this instrument, it must be returned to our laboratory if the single thermocouple is burned out, or, if both thermocouples are inoperative on the DeLuxe models unless spare replacement thermocouples were supplied with the instrument while it was in our possession.

Our Deluxe A.C.-D.C. Self Checking Volt-Amp-Milliammeters are equipped with two matched vacuum thermocouples, either of which can be used by turning a selector switch. The purchase of this Deluxe model is recommended where this standard instrument cannot be allowed to become out of service. Only when BOTH couples have been damaged will it be NECESSARY to return the instrument to the factory for repair.

MODEL B



Equipped with *"Diamond Pivots"*

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.1 of 1% (ABS)
SCALE LENGTH	12 inches
SCALE DIVISIONS	100 or 150 (Vernier)
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Walnut-Bakelite panel
SIZE	16⅛" x 14¼" x 4"
INST. WEIGHT	17 pounds
SHIP. WEIGHT	40 pounds

CALIBRATED IN THE "ABS" SYSTEM

Our "one tenth of one per cent" Laboratory Standard instruments will be found extremely valuable in electrical measurement standardization work. They represent the finest of our instruments . . . finest as regards mechanical construction, electrical efficiency, accuracy, stability of component parts, readability and physical appearance. These desirable qualities may be attributed to the expert craftsmanship of our experienced instrument makers and the untiring efforts in design and development of our Engineering Department. These instruments have been tested and internationally accepted as ELECTRICAL MEASUREMENT STANDARDS for the past 29 years. It is indeed rare that one may walk into a governmental, industrial or educational Standards Laboratory and not find a SENSITIVE RESEARCH Laboratory Standard in use.

The instrument is supplied in a circassian walnut case with a highly polished bakelite insulating panel. Mounted on each panel is an accurate leveling bubble to duplicate, in use, the exact position in which the instrument was calibrated. Adjustable screw leveling feet facilitate this positioning process which guarantees an optimum of accuracy.

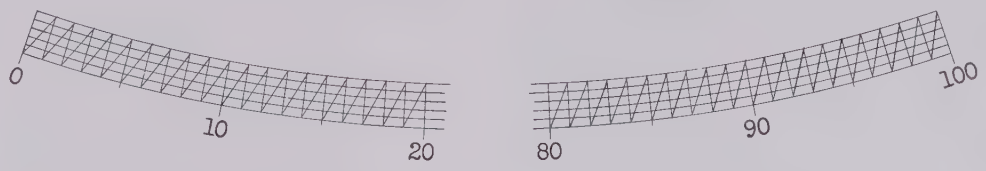
The basic electrical movement in these instruments is the D'Arsonval type. Magnets used in these instruments have been aged for not less than four years to insure stability. Springs have been designed to insure a minimum of fatigue and excellent reproducibility of deflection. We use *"Diamond Pivots"* and shock mounted jewels exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. These pivots reduce the friction to a completely negligible level. Diamond pivots will withstand the tremendous impact of a three foot drop without deformation to either the pivot or jewel. The instruments are electrostatically shielded and have conducting instrument glass windows.

The electrical circuits of D.C. Laboratory Standards have been designed for electrical efficiency and have negligible temperature errors over ordinary room temperature variations. Special techniques of temperature compensation are employed in order to more fully bring to the user a maximum of accuracy.

Stability of component parts and calibration is another quality inherent in these instruments. This is brought about by accelerated life ageing of each individual standard before it leaves our laboratory. The instrument is continually deflected "on and off" for several days while going through a hot and cold cycling stabilization period.

MODEL B

The scale length of the Laboratory Standard is 12 inches. It is hand drawn on a brass backed white enamel scale, absolutely warp-proof, allowing the placing of fine precision lines. For accurate reading, each scale division is divided by a system of vernier lines. With the aid of a fine knife edge pointer and an anti-parallax mirror, the instrument may be read to an accuracy greater than 1/10th of 1%. With this available accuracy it is not necessary to supply calibration curves.



SECTION OF TYPICAL D.C. VERNIER SCALE

MICROAMMETERS

Full Scale Microamperes	Code Word	Price
*30	BAMICO	$725.00
50	BAMICH	610.00
100	BAMICY	590.00
200	BAMICT	575.00
500	BAMICA	575.00

*Accuracy .15% on this instrument.

MILLIAMMETERS

Milliamperes		
1	BAMILL	$565.00
5	BAMILS	565.00
10	BAMILT	565.00
30	BAMILA	565.00
75	BAMILY	565.00
150	BAMILI	565.00
300	BAMILO	565.00
500	BAMILU	565.00

MILLIVOLTMETERS

(approximately 100 ohms per volt)

Millivolts		
50	BAMVLT	$650.00
100	BAMVOK	650.00
50/100	BAMVPS	750.00

These MILLIVOLTMETERS are temperature compensated for ambient changes from 20°C. to 30°C. Please specify if 100 or 150 division scales are desired. If both 100 and 150 divisions are desired, add $42.00 to instrument cost.

External heavy current shunts for use with above millivoltmeters, See shunt index.

VOLTMETERS

(1000 ohms per volt)

	Code	Price
3/7.5/15/30/75/150/300	BAVOST	$ 800.00
3/7.5/15/30/75/150/300/750	BAVOKI	850.00
5/10/20/50/100/200/500/1000	BAVOMO	874.00

MULTIRANGE MILLIAMMETERS

Full Scale Milliamperes	Code	Price
*.03/.15/.3/1.5/3/15/30/150/300	BAMILXO	$1050.00
.05/.1/.5/1/5/10/50/100	BAMILJI	920.00
.1/.5/1/5/10/50/100/500	BAMILEK	875.00
.5/1/5/10/50/100/500/1000	BAMILUK	775.00
.3/.75/1.5/3/7.5/15/30/75/150	BAMILOP	800.00
1/2/5/10/20/50/100/200/500/1000	BAMILOO	834.00
1.5/3/7.5/15/30/75/150/300/750/1500	BAMILEE	834.00

*Accuracy .15% on this range.

**MULTIRANGE AMMETERS

Amperes		
.3/1.5/3/15/30	BAANKET	876.00
5/10/20/50	BAAMEX	958.00

**Supplied with external shunt boxes.

Two man Laboratory calibration of a Multirange DC Laboratory Standard Milliammeter in the ABS System.

MODEL L

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.1 of 1%
SCALE LENGTH	12 inches
SCALE DIVISIONS	100 or 150 (Vernier)
PERIOD	3 - 5 seconds
TYPE	Electro-Dynamometer
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Walnut-Bakelite panel
SIZE	16⅛" x 14¼" x 6¼"
INST. WEIGHT	17 pounds
SHIP. WEIGHT	40 - 50 pounds

Our Model "L" A.C. Laboratory Standard instruments are fitting companions for our DC Standards. They have a clean cut, modern and dignified appearance. They, too, are supplied in solid circassian walnut cases with highly polished bakelite insulating panels, an accurate leveling bubble, and leveling feet.

.1 OF 1% LABORATORY STANDARD INSTRUMENTS demand every bit of engineering skill at the designer's command. Mechanically, they must have very strong, accurately machined parts. There must be no spring, no play, and no changeability of the parts' position.

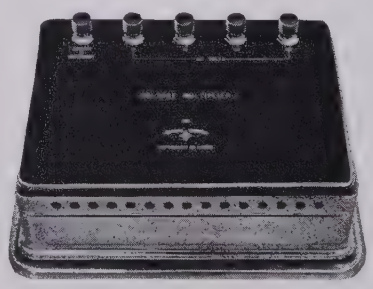
Electrically and magnetically there must be **NO** change and **NO** ageing. Consequently, every standard instrument is carefully calibrated after an accelerated life test of "on-off" deflections while going through a controlled temperature cycle.

The model L A.C. instrument is of the electrodynamometer type. The mutual action of the currents in the field coils and moving coil produce a torque which is proportional to the square of the current being measured. Since a dynamometer must of necessity operate with a weak field, it could be affected by stray fields. To further insure its accuracy in use, we have the basic movement (fields and moving coil) surrounded with a laminated iron shield to guard against any extraneous fields. The instruments are electrostatically shielded including conducting instrument glass windows.

Wave form variations from the pure sine wave will not affect the accuracy of the dynamometer instrument as it is essentially an RMS reading device. However, since the electrodynamometer type of instrument has inherent frequency limitations, currents containing large components of higher harmonics may cause slight errors in reading.

Model L instruments are characterized by high torque and sustained accuracy under adverse conditions. They are calibrated at 25°C.

These instruments can be supplied with calibrations at any SINGLE frequency up to 1000 cycles on special order at an additional charge of $50 per range. Such instruments are then accurate at the ONE FREQUENCY ONLY. For compensated instruments for use from 50 to 400 cycles, see next page.



EXTERNAL VOLTAGE MULTIPLIER

MODEL L

Damping in this type of instrument is accomplished by the use of light weight aluminum vanes in an accurately formed air tight chamber.

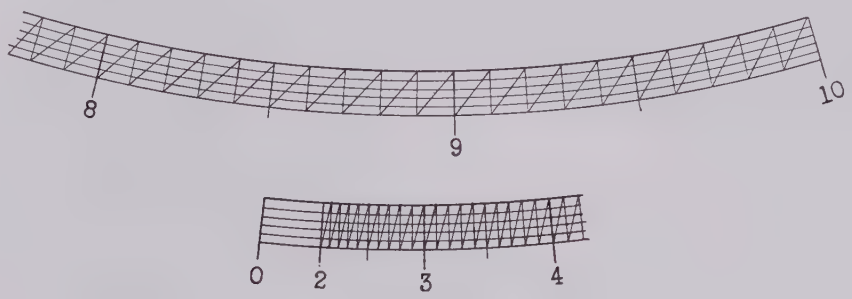
We use *"Diamond Pivots"* and shock mounted jewels exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. These pivots reduce the friction to a completely negligible level. Diamond pivots will withstand the tremendous impact of a three foot drop without deformation to either the pivot or jewel.

Springs are made of a composition which is the result of extensive research. These springs are unusually strong with a very low temperature coefficient of elasticity, extreme freedom from set and negligible fatigue.

The pointer construction is a vital part of A.C. instruments. Our pointers are made rigid, light and free from resonant vibrations and are individually tested over the frequency range of the instrument, before assembly.

Scales are calibrated and hand drawn on a brass backed white enamel coated scale. By the use of this material, warping and shredding of scales are eliminated. A vernier system of marking is used to subdivide the divisions into tenths on the scale.

The instrument glass is a special clear, heavy plate which is electrically conducting and internally grounded. This prevents any calibrating errors which might result from external electrostatic charges caused by cleaning the glass.



Shown are full size sections of a typical vernier A.C. laboratory standard scale

FOR USE AT DC & 25 TO 125 CYCLES

Supplied with separate shunt or multiplier boxes.

FOR USE AT **DC & 50 TO 400 CYCLES

MILLIAMMETERS

Full Scale Milliamperes	Code	Approx. Burden in VA at 60 Cycles	Price
* 50/100	LABMIL	10	$705.00
* 75/150	LABNOT	10	705.00
*100/200	LABNAK	10	705.00
*150/300	LABMOR	10	705.00
500/1000	LABMUD	10	705.00
750/1500	LABMEX	10	715.00

*Shunts mounted inside case.

AMMETERS

Amperes	Code		
1/2	LABAST	10	722.00
1.5/3	LABAMP	10	722.00
2.5/5	LABAMK	10	722.00
5/10	LABAMI	15	722.00
7.5/15	LABAMU	20	760.00
10/20	LABAMO	20	772.00

VOLTMETERS

Full Scale Volts	Code	Approx. Ohms per Volt	Price
75/150/300	LABVOI	25	$750.00
30/75/150/300	LABVOL	17	842.00
50/100/200/500	LABVOM	20	858.00
75/150/300/750	LABVOS	25	884.00
100/200/500/1000	LABVOX	50	902.00

MILLIAMMETERS

Full Scale Milliamperes	Code	Approx. Burden in VA at 60 Cycles	Price
50/100	LABMIL-X	50	$905.00
75/150	LABNOT-X	50	905.00
100/200	LABNAK-X	40	905.00
150/300	LABMOR-X	40	905.00
500/1000	LABMUD-X	40	905.00
750/1500	LABMEX-X	40	915.00

AMMETERS

Amperes	Code		
.5/1	LABAMS-X	40	$905.00
1/2	LABAST-X	40	922.00
1.5/3	LABAMP-X	40	922.00
2.5/5	LABAMK-X	40	972.00

VOLTMETERS

Full Scale Volts	Code	Approx. Ohms per Volt	Price
30/75/150	LABVOP-X	6	$875.00
50/100/200	LABVOK-X	10	950.00
75/150/300	LABVOI-X	15	975.00
100/200/500	LABVOA-X	18	1020.00
150/300/750	LABVOB-X	20	1060.00
200/500/1000	LABVOK-X	30	1100.00

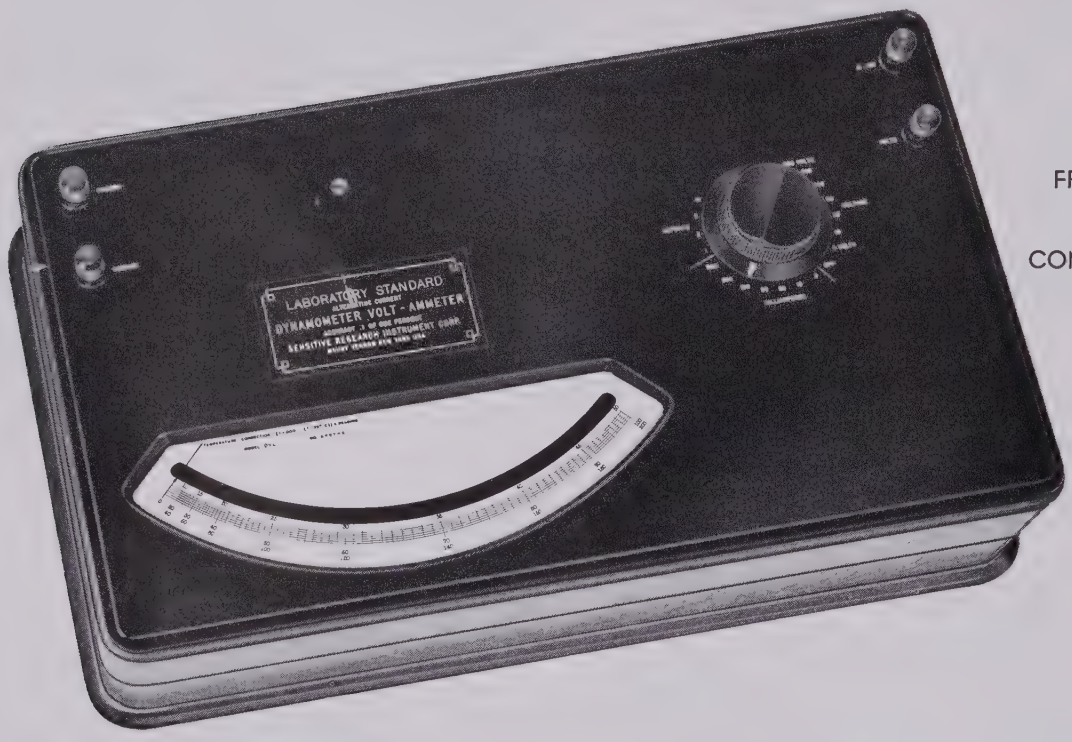
**Higher frequency instruments necessarily have higher power consumption than 60 cycle instruments.

1000 cycle instruments available on special order having range multipliers of not over a 2 to 1 ratio. Correspondence with us necessary for 1000 cycle instruments.

MODEL **DYL**

ANOTHER *FIRST* BY "SENSITIVE"

AN A. C. "LABORATORY STANDARD" DYNAMOMETER



MADE IN TWO FREQUENCY RANGE COMBINATIONS

CURRENT RANGES

10-20-50-100-200-500 MILLIAMPERES
1-2-5-10 AMPERES

VOLT RANGES

20-50-100-200-500 VOLTS

The Dynamometer moving element used is the very latest creation of "SRIC" incorporating the most modern techniques. As this instrument uses an internal instrument transformer it cannot be used on direct current.

This instrument is available in two frequency ranges. 50 to 70 cycles and 380 to 420 cycles. Our code DYNLAB-S (50 - 70 cycles) has an accuracy of .1 of 1%. The code DYNFRE-S (380 - 420 cycles) has an overall accuracy of .15 of 1%. The current and volt ranges of the above instruments are identical.

When used in commercial power circuits the wave form error in these instruments can be considered a negligible quantity.

SPECIFICATIONS

HORIZONTAL USE ONLY

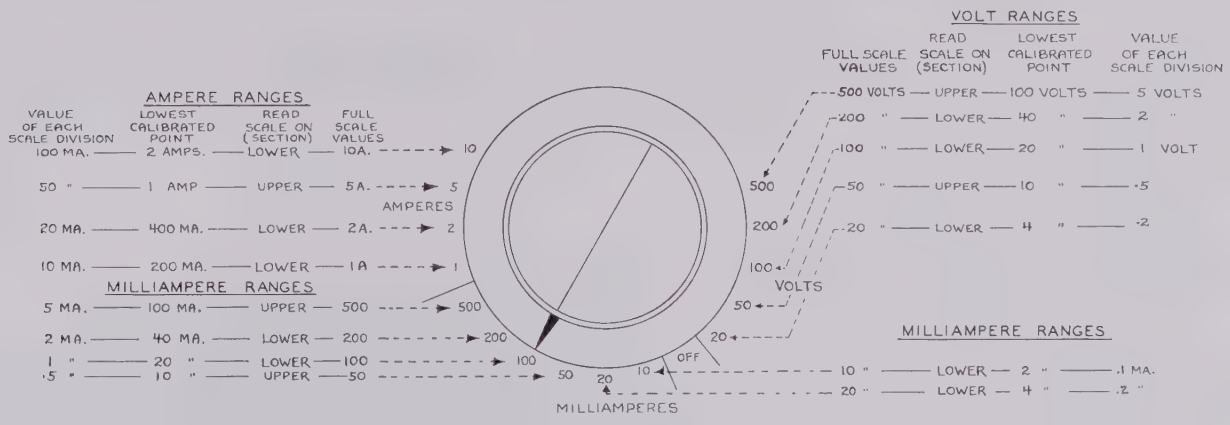
ACCURACY	.1 of 1% (50-70 cy.) .15 of 1% (380-420 cy.)
SCALE LENGTH	12 inches
SCALE DIVISIONS	100
PERIOD	4 - 5 seconds
TYPE	Dynamometer
PIVOTS	Diamond
JEWELS	Sapphire Spring mounted
SHIELDING	Magnetic & Electrostatic
CASE	Walnut & Polished Bakelite panel
SIZE	24" x 14" x 8"
INST. WEIGHT	30 pounds
SHIP. WEIGHT	50 pounds

OPERATION

The operation of this fine instrument is very simple. There are two binding posts for current on the left top of the panel and two for voltage on the right top of the panel.

A single master range switch selects the desired range either in VOLTS, AMPERES or MILLIAMPERES.

The self explanatory drawing below shows in detail the range spread and values of each range position of the selector switch as well as the proper figures of the scale to read. Drawing below is for code DYNLAB-S.


VOLT RANGES
FULL SCALE VALUES
READ SCALE ON (SECTION)
LOWEST CALIBRATED POINT
VALUE OF EACH SCALE DIVISION
500 VOLTS — UPPER — 100 VOLTS — 5 VOLTS
200 " — LOWER — 40 " — 2 "
100 " — LOWER — 20 " — 1 VOLT
50 " — UPPER — 10 " — .5
20 " — LOWER — 4 " — .2
AMPERE RANGES
VALUE OF EACH SCALE DIVISION
LOWEST CALIBRATED POINT
READ SCALE ON (SECTION)
FULL SCALE VALUES
100 MA. — 2 AMPS. — LOWER — 10A. — 10
50 " — 1 AMP — UPPER — 5A. — 5
AMPERES
20 MA. — 400 MA. — LOWER — 2A. — 2
10 MA. — 200 MA. — LOWER — 1A — 1
MILLIAMPERE RANGES
5 MA. — 100 MA. — UPPER — 500 — 500
2 MA. — 40 MA. — LOWER — 200 — 200
1 " — 20 " — LOWER — 100 — 100
.5 " — 10 " — UPPER — 50 — 50
500
200
100
VOLTS
50
20
10
OFF
MILLIAMPERES
MILLIAMPERE RANGES
10 " — LOWER — 2 " — .1 MA.
20 " — LOWER — 4 " — .2 "

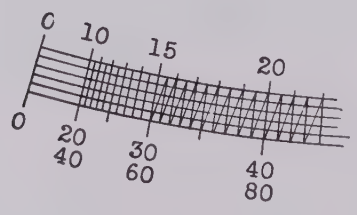
RANGE SELECTOR SWITCH

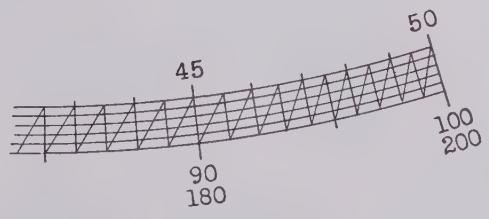
As a safety suggestion in using multirange instruments —always start with the selector switch on its highest value either in current or voltage.

Then, with the voltage or current on, turn the selector switch down to the more sensitive ranges until a suitable reading is obtained.

Try always, if possible, to read near full scale. This will help you to obtain the best observable accuracy of the electrical value being measured.

FACSIMILE SCALE





"LABORATORY STANDARD" DYNAMOMETER POLYRANGERS

MODEL DYL — SCALE LENGTH 12 INCHES

RANGES		*FREQUENCY*	*CODE*	*PRICE*
10/20/50/100/200/500 MILLIAMPERES 1/2/5/10 AMPERES 20/50/100/200/500 VOLTS	15 SELF CONTAINED RANGES	50 - 70 CYCLES (Accuracy .1 of 1%)	DYNLAB-S	$1780.00
		380 - 420 CYCLES (Accuracy .15 of 1%)	DYNFRE-S	$2280.00

The DYL consumes approximately 1/3 watt on ALL current ranges and approximately 10 watts on ALL voltage ranges. These values apply to the 50 - 70 cycle instrument. The 380 - 420 cycle instrument consumes somewhat higher power.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.05 of 1%
EFFECT. SCALE LGTH.	63 inches
EFFECT. SCALE DIV.	1000
PERIOD	5 seconds
TYPE	Differential
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Electrostatic
CASE	Walnut & Polished Bakelite panel
SIZE	16⅜" x 10½" x 8¾"
INST. WEIGHT	21 pounds
SHIP. WEIGHT	Approx. 35 pounds

DIRECT CURRENT

DIFFERENTIAL "63" INCREMETER

MODEL **INCRE**

PORTABLE

OR

PANEL MOUNTED

EFFECTIVE SCALE LENGTH, 63 inches

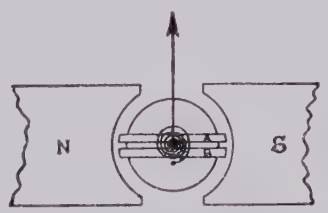
EFFECTIVE SCALE DIVISIONS — 1000

This new DIFFERENTIAL INCREMETER is a unique combination of the very old and the completely new in instrumentation. Differential instruments have been used for high accuracy comparisons for many years. Now, due to extensive development work at "SENSITIVE RESEARCH" we have combined differential instrument "High *COMPARATIVE* Accuracy" with a "HIGHLY Accurate" stable reference source and produced a 63 inch scale instrument with .05% accuracy. The DIFFERENTIAL INCREMETER has a 6.3 inch scale.

The addition of an expansion circuit allows this 6.3 inch scale to be effectively spread out to ten times its own length. This is accomplished by making it read in successive positions, zero to .1 of full scale, .1 to .2 of full scale, .3 to .4 of full scale, etc. This makes feasible an instrument "readability" never before attained in direct indicating instruments. It creates a 63 inch, ONE THOUSAND division scale, with an absolute accuracy of one-half division and stability and readability of a small fraction of this half division.

The torque producing mechanism of the well-known moving coil, permanent magnet type of instrument is an efficient device. The current through the moving coil which is sufficient to drive the pointer to full scale is relatively small in comparison to the maximum current carrying capacity of the wire used. Current of MANY TIMES the full scale current can be sent through the moving coil without causing overheating of the coil and consequent loss of accuracy. These higher currents must be applied slowly or the movement must be heavily damped to prevent mechanical damage as the pointer attempts to move to a position many times past full scale. This mechanical protection can be easily accomplished by means of eddy current damping.

The above "FACTS OF LIFE" for DC movements are exploited in the differential moving coil system shown in figure #1.



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In this system there are two electrically independent coils wound on the same moving assembly. It is obvious that either of these coils can be used by itself to operate the pointer in a perfectly normal manner. When the two coils are supplied with current simultaneously and with the same polarity the torques produced by the respective currents will ADD and produce a deflection proportional to the SUM of the two currents. If, however, the two currents are supplied with OPPOSITE POLARITIES the net torque will be proportional to the DIFFERENCE of the two currents. When these two currents are equal to each other the net torque is ZERO regardless of their magnitude. Let us assume that we make a movement with a zero center pointer and with coils such that either one by itself will swing the pointer to full scale (left or right) for 50 milliamperes. If we further assume a 100 division scale marked 50 - 0 - 50, we have a complete and useful instrument. This movement can now be supplied with 49 milliamperes in one coil and 50 milliamperes in the other coil. The net torque of these two currents if they are of opposite polarity will be sufficient to cause a 1 division deflection in the direction of the larger current. If we know the 50 milliamperes to be accurate, we then know that the smaller current is 49 milliamperes (50 - 1). Our comparison sensitivity is 1 division. This is a 2% difference between the currents (1 div. in 50 equals 2%).

It is possible to take advantage of the inherent overload of the differential moving coil system as brought out in paragraph one. Instead of 49 and 50 milliamperes we can use currents of 499 and 500 milliamperes without in any way damaging the coils. A deflection will be obtained of one division, the same as before, because the difference is still 1 milliampere (500-499). However our comparison sensitivity is now 1 division in 500, or .2%, a gain in comparison sensitivity of 10 times, the exact factor by which we were able to run excess current through the movement. This basic increase in comparison sensitivity by making use of the overload characteristics of such moving coil systems has been recognized for many years. The only drawback to the realization of greater accuracy by use of differential instruments was in the obtaining of a satisfactory reference current to supply one of the two currents in order to change the HIGH COMPARATIVE accuracy into a HIGH ABSOLUTE ACCURACY. This ordinarily required a standard cell and galvanometer and constant rechecking and adjustment in order to maintain a satisfactory reference.

New "SENSITIVE RESEARCH" engineering advances in the design of miniature high stability power supplies have been used by us to produce a compact "BLACK BOX" reference source with very unusual characteristics. Using regulation—on regulation—on regulation techniques we have designed a compact supply capable of furnishing 1 milliampere D.C. reference currents from a 60 cycle line that are phenomenally stable. Within the limits of line voltage variations from 90 to 135 volts and ambient temperature variations of 10 to 40 degrees Centigrade, these supplies will furnish a reference 1 milliampere with a stability of appreciably better than .01% and with a design life expectancy in excess of 25,000 hours.

In figure #2 a typical differential movement is combined with our design stable reference source to provide an extremely high accuracy DC instrument with a wide range of measurement and several unique features. The basic differential movement in this case has a sensitivity of 0 to 100 microamperes in each section. If the instrument is used on the most sensitive current range (0 to 1 milliampere) and the switch on the reference half of the instrument is set at 0 - .1, there is no reference current supplied, and the instrument will deflect full scale for 100 microamperes (.1 of 1 milliampere). If the suppression switch is now turned to the .1 - .2 position, a portion of the reference current is fed into the other half of the instrument moving coil system. Actually 100 microamperes is now flowing in the reference half and it would take 100 microamperes from the external source merely to bring the pointer to zero, therefore 200 microamperes will be required for full scale deflection. In other words the scale now reads not 0 to .1 milliamperes but .1 to .2 milliamperes. Similarly as we rotate the suppression switch we put greater currents through the reference half of the differential moving coil system and the scale reads progressively .2 to .3 ma., .3 to .4 ma., etc., up until with 900 microamperes flowing in the reference circuit, the scale reading is .9 to 1.0 milliampere. In effect we have "expanded" each tenth of the normal 0 to 1 milliampere scale of 6.3 inches into a full scale deflection of its own for a total effective scale length of 63 inches.

The accuracy of such a radically different type of instrument must be very carefully stated and understood for the completely satisfactory usage of this new instrument.

DIFFERENTIAL "63" INCREMETER

For any given range there are ten different sets of scale readings obtainable from 0 - .1 to .9 - 1.0 of the particular range involved. The accuracy is stated in terms of the FULL SCALE value of THE RANGE IN USE, regardless of what particular small section of that range the scale may be reading at the moment. This means that the 1 volt range which is spread over 63 inches of total scale length with 1000 scale divisions has an accuracy of .05% of full scale (.05% of 1 volt) which is ± .5 millivolt. This is true regardless of whether the scale is reading 0 - .1 volt, .2 - .3 volt or .9 - 1.0 volt at the moment. The accuracy is stated in terms of the full range in use without regard to the section which may be expanded at the time.

Accuracies are always stated in terms of Absolute values of current and/or voltage applied. In this particular type of instrument the resolution and repeatability of the readings are very markedly in excess of the absolute accuracy which can be guaranteed. Readings can easily be made to a resolution of .02% as this requires only the estimation of fifths of a division.

The repeatability of readings is even better than this, being in the order of .01%. These are phenomenal values of instrument readability and stability, never before achieved with direct reading instruments. These previously unheard of accuracies pose problems in the actual calibration of such instruments. For instance, in calibrating with the well known BROOKS POTENTIOMETER, (a widely used instrument in instrument standardizing laboratories) the pointer movement of the DIFFERENTIAL 63 INCREMETER is greater than the galvanometer pointer movement on the potentiometer. Many of the instrument's internal resistors must be adjusted using the instrument as its OWN INDICATOR because the instrument will show .01% variations quite readily which the usual bridges do not indicate. The very high readability of these instruments, (.1% is a full division) shows up power supply variations and similar slight variables that are ordinarily not noticed. In fact, until the user becomes familiar with this tremendous scale expansion it is very surprising to find that things are not quite as stable as believed.

We welcome suggestions from you — our customer friends — on possible applications of this new unusual measuring instrument development.

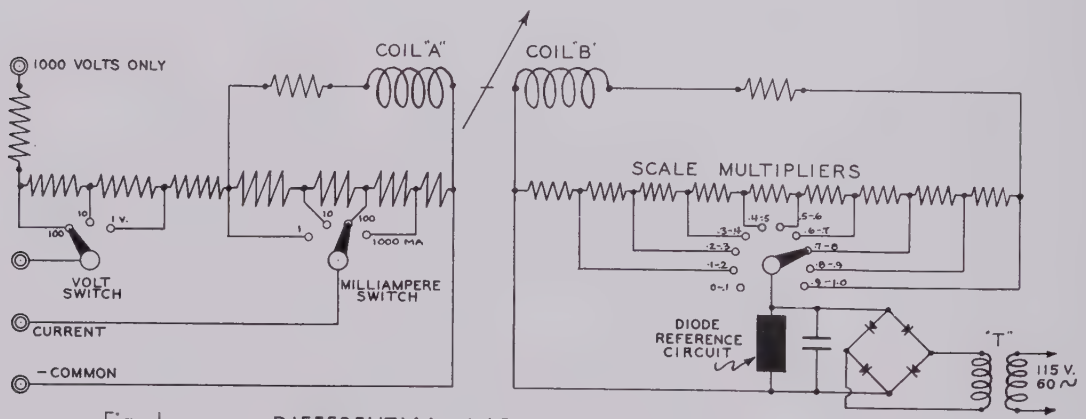


Fig. 1 DIFFERENTIAL INCREMETER CIRCUIT

ACCURACY .05 OF 1%

The accuracy is stated in terms of full scale of the range being used and is ± .05% of this value regardless of the scale expansion factor in use.

Over the total range spread of 0 - 1 MA. (0 - .1, .1 - .2 . . . .9 - 1.0) the accuracy is ± .5 microampere The range spreads are as shown below:

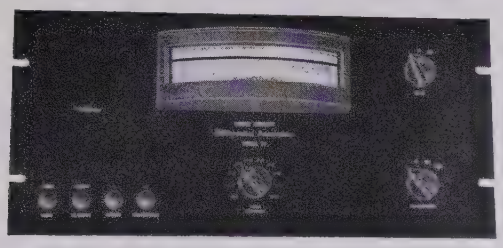
0 - 1 Ma. range spread is ± .5 Microampere	0 - 1 Volt range spread is ± .5 Millivolt
0 - 10 Ma. range spread is ± 5 Microamperes	0 - 10 Volt range spread is ± 5 Millivolts
0 - 100 Ma. range spread is ± 50 Microamperes	0 - 100 Volt range spread is ± 50 Millivolts
0 - 1000 Ma. range spread is ± .5 Milliampere	0 - 1000 Volt range spread is ± .5 Volt

The above accuracies apply for all positions of the range expansion switch. For example: 850 microamperes reads on the 1 ma. range with the expansion switch at .8 - .9 with an accuracy of ± .5 microampere.

Ranges	Code Word	Effective Scale Divisions	Price
1/10/100/1000 Volts (1000 ohms per volt) 1/10/100/1000 Milliamperes	SUPRES	1000	$860.00

(Total effective scale length, 63 inches)

Rack mounted "Incremeters" available — (see next page)



Size — 19" x 8¾"
Depth behind panel — 5 inches
in Black Bakelite or Gray Finished Aluminum

PANEL MOUNTED D.C. DIFFERENTIAL "70" INCREMETER

Using our edgewise reading panel instrument with its seven (7") inch scale length we have available an instrument with an effective 70" scale length.

All connections are available at binding posts on the front panel and on terminals in the rear for permanent wiring. The ranges are identical with that of the portable "63" Incremeter.

MODEL INCRE

ELECTRICALLY SUPPRESSED ZERO D.C. INSTRUMENTS

PORTABLE OR PANEL MOUNTED

PORTABLE CASE — 13¾" x 7½" x 8¼"

PANEL SIZE — See photo above

Using our new high stability power supply controlled by an almost unbelievably accurate diode reference circuit, we now have available a series of ELECTRICALLY SUPPRESSED ZERO instruments. Such instruments are markedly different and superior to any other suppressed zero, narrow range instruments.

The greater the electrical suppression, the greater the accuracy with this type of instrument, and suppressions of up to 90% are completely satisfactory and will allow accuracies of .05%.

The suppression current is obtained from the 115 volt 60 cycle line (available for 50 cycle on special order) and is regulated within .01% for line voltage variation between 90 and 130 volts and for a temperature range of 10 deg. C to 40 deg. C.

These instruments are extremely easy to use. Simply turn on power (115 volts, 60 cycles) and use. Power consumption from line is only 25 va.

This "NEW" SENSITIVE RESEARCH type of ELECTRICALLY SUPPRESSED ZERO instrument can be furnished in any range of current of 200 microamperes or more and any range of voltage of 200 millivolts or more and with any degree of expansion up to 90%. By 90% expansion is meant that for whatever the range of the instrument is only the portion from 90% to 100% appears on the scale and all values below 90% of full scale will be below the lowest scale marking, i.e.: off scale to the left in the usual instrument. Accuracies obtained will be as follows: 50% suppression gives .25% accuracy—80% suppression gives .1% accuracy and 90% suppression (the maximum allowable suppression) will give an accuracy of .05%. All accuracy values are given in terms of percentage of full scale.

POPULAR RANGES OF ELECTRICALLY SUPPRESSED ZERO DIRECT CURRENT VOLTMETERS

Ranges listed below are only samples of what can be furnished. The purchaser can select any range or ranges desired to fit the requirements of his application — as long as they are within the minimum specifications listed for the incremeter.

Full Scale Volts	*Scale Length	Accuracy % of Full Scale	Code Word	Price
6 - 7	7"	.075%	SUPVOL	$464.00
6 - 8	7"	.10 %	SUPVOM	464.00
12 - 14	7"	.075%	SUPVOT	464.00
24 - 28	7"	.075%	SUPVOK	464.00
110 - 120	7"	.05 %	SUPVOY	464.00

Voltmeters available down to .2 volt full scale. Correspondence solicited.

MULTIRANGE D.C. VOLTMETERS

6 - 7 / 12 - 14 / 24 - 28	7"	.075%	SUPMOB	$534.00
100 - 110 / 110 - 120 / 120 - 130	7"	.05 %	SUPMOC	$534.00
100 - 130 / 200 - 260 / 400 - 520	7"	.10 %	SUPMOD	544.00
50 - 100 / 100 - 200 / 200 - 400	7"	.25 %	SUPMOF	544.00

The above instruments in general limited to 3 scales due to the necessary scale space required for printing of scale numbering.

D.C. CURRENT INSTRUMENTS

Any current available from 200 microamperes and up. For special requirements, correspondence required.

*Scale length for panel mounted
Scale length for portable is 6.3".

MODEL **CHC**

DIRECT READING HEAVY CURRENT D. C. AMMETER

ACCURACY .2 OF 1%

SCALE LENGTH 6.3 INCHES

DIAMOND PIVOTED!

Available in Two Range Combinations

The new heavy current precision D.C. Ammeter is our solution to the need of measuring a wide range of *HEAVY* D.C. currents—*accurately*—at a moderate cost.

This new instrument is simple and easy to use, does away with the necessity of carrying a whole armful of shunts with their long leads and the millivoltmeter.

It is entirely self-contained. It consists of a long scale precision millivoltmeter, ring connected to a series of precision adjusted current shunts. To obtain any range, simply plug the tapered hole at the range desired. This plug and the heavy current blocks are specifically designed to create a low resistance current circuit.

Current flowing through the selected shunt creates a D.C. millivolt drop (50 millivolts) which is measured on the instrument's internal millivoltmeter. Its scale is calibrated and hand drawn, reading directly on the selected range.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.2 of 1%
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100 or 150
PERIOD	2 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Walnut- Polished Bakelite
SIZE	16⅜" x 10½" x 8¾"
INST. WEIGHT	21 pounds
SHIP. WEIGHT	40 - 50 pounds

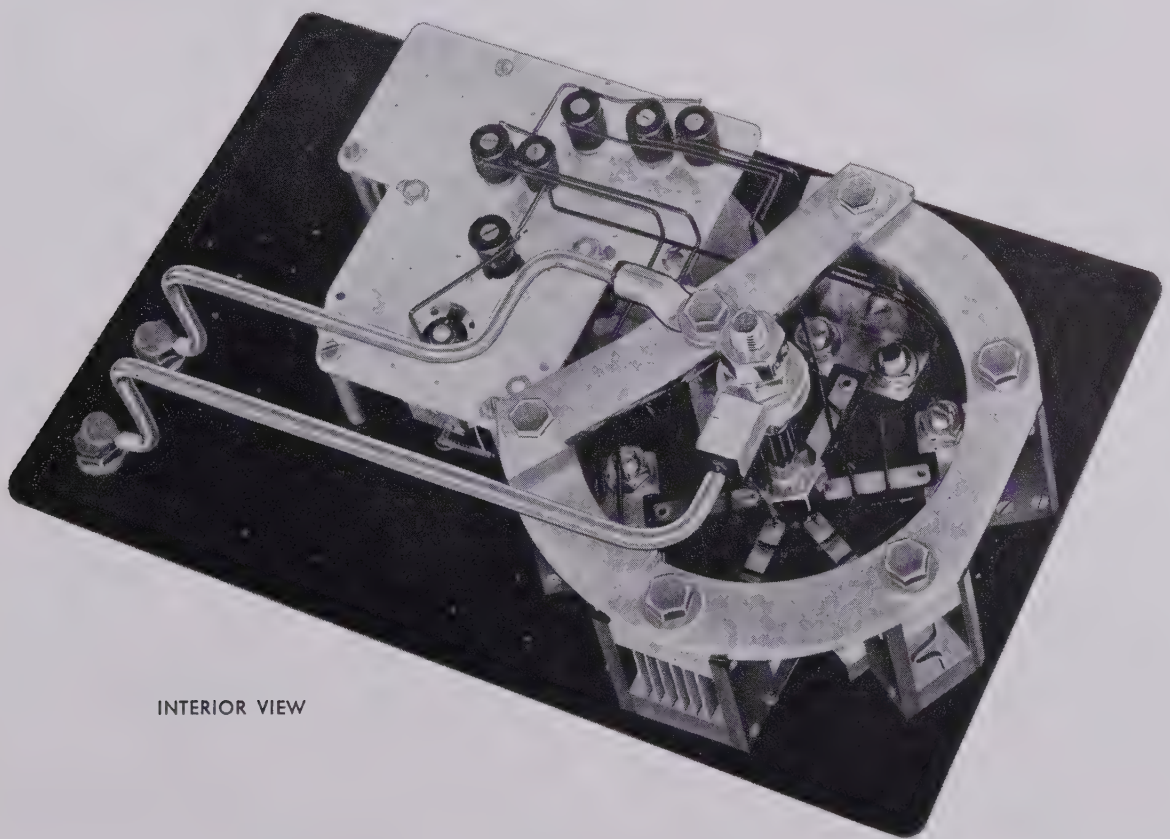
MODEL CHC

The accuracy rating of this instrument at .2% is ample to allow it to be used for precision calibration work. The millivoltmeter movement used is DIAMOND PIVOTED for the utmost in reliability and fine performance. Its DIAMOND PIVOTS are combined with shock mounted jewels and high torque springs, to provide an extremely sturdy, stable instrument. The instrument is temperature compensated to show negligible errors over the usual laboratory range of 20 to 30 degrees Centigrade.

All laboratories will find this heavy current DC instrument a very satisfactory investment. It will be particularly welcome where there is a great amount of high current calibration required, because of the speed of range changing. There are no cumbersome shunts or leads to connect and reconnect, (just a simple plug to change the range). A spare plug is supplied as standard equipment.

The instrument is supplied mounted in a beautiful walnut case with dust cover. The top surface is of highly polished black bakelite. The case size when covered is 16⅜" x 10½" x 8¾". Weight 21 lbs.

RANGES	CODE	PRICE
0 - 1/5/10/20/50/100 Amperes	CHARLIE	$875.00
0 - 1.5/3/7.5/15/30/75 Amperes	CHARITA	875.00



INTERIOR VIEW

showing DC millivoltmeter on left and "ring connected" 50 millivolt shunts on right.
The full scale adjusting resistance bobbins are shown mounted on the millivoltmeter base plate.

MODEL **LW**

LABORATORY STANDARD WATTMETERS

FOR DIRECT AND ALTERNATING CURRENT

SPECIFICATIONS

HORIZONTAL USE ONLY

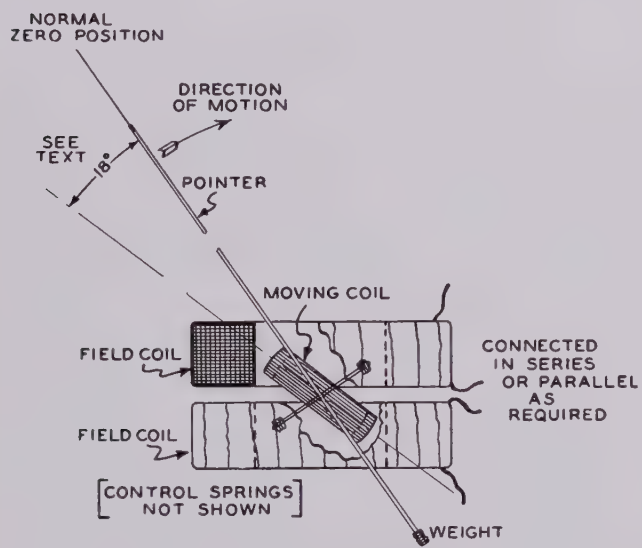
POWER FACTORS	Down to 80%
ACCURACY	.1 of 1%
SCALE LENGTH	12 inches
SCALE DIVISIONS	100 or 150
PERIOD	2 - 3 seconds
FREQUENCY	DC & 25 - 125 cycles
TYPE	Dynamometer
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Walnut with highly polished panel
SIZE	16⅜" x 14¼" x 6¼"
INST. WEIGHT	25 pounds
SHIP. WEIGHT	43 pounds

LABORATORY STANDARD WATTMETERS may well represent the ultimate in instrument design problems. So many factors are involved in the accuracy of a wattmeter, in addition to the general design problems of other high accuracy instruments that it taxes the designer's ingenuity to make all the necessary compromises.

SENSITIVE RESEARCH INSTRUMENT CORPORATION wattmeters use the same basic dynamometer movement and diamond pivots used in our Model L ammeters and voltmeters. This consists of a moving coil assembly swinging in the field produced by current through a pair of field coils as shown in Fig. 1. All the usual precautions applied to ammeters and voltmeters have to be considered in wattmeter designs.

The choice of turns and wire size for both the moving coil and the field circuit is critical. Maximum torque is required to keep friction and stability errors as low as possible. However, a severe limitation is reached on maximum available torque because of the heating in the coils themselves. Very careful compromises must be made in these respects, if we are to stay within the minute tolerances necessary in making an instrument with an accuracy of 1% of full scale value.

To obtain the best scale spread the pointer position in respect to the coil is carefully controlled, as this enhances markedly the readability of the instrument. In addition,



① BASIC WATTMETER ASSEMBLY

the scale ranges are chosen to be read on a single 12" scale with a precision vernier. This type of precision scale allows maximum reading accuracy and contributes greatly to the actual useage of the instrument to its full inherent accuracy.

After the precautions mentioned before have been taken there remains another serious error possibility that is peculiar to a wattmeter. In both a voltmeter and an ammeter we are involved with a single current flowing through both the moving coil and the field coils. The fundamental equation for instrument torque is

$$\text{Torque} = KNI_{mc} \times NI_{fc} \times \text{Cos } \theta.$$

As NI_{mc} and NI_{fc} are the same current, Cos θ is zero and drops out of the picture. Cos θ may not be zero in shunted types of ammeters but it is at least constant and appears as part of calibration constant K. In the wattmeter the potential circuit furnishes NI_{mc} and the current circuit furnishes NI_{fc} and Cos θ is variable and can assume any value within the rating of the instrument. Herein lies one of the traps that are so easy to fall into. The fundamental equation is given above as it is usually stated. Actually it is

$$\text{Torque} = K \phi_{mc} \times \phi_{fc} \times \text{Cos } \theta$$

ϕ = flux produced by the respective coils.

In other words, the actual torque is proportional not to the ampere turns but to the fluxes produced by those ampere turns. Ordinarily, in air cored coils the flux is considered to be identical in phase to the current. But actually in any realizable coil there are some eddy current effects which cause the phase of the flux to lag the current producing it by some slight amount.

These eddy currents are in the metal supports for the coils, in the shields and even in the coil conductors themselves. These lagging fluxes are not identically delayed in both the fields and the moving coil. The difference in these two delays is effectively added or subtracted from Cos θ as an error effect.

A new shield design has been developed especially for the Model LW instrument and uses the best of the new thin gauge crystal aligned silicon steels. Metal supports have been redesigned using high resistivity alloys. All of these combine to keep the actual phase angle error of the Model LW down to 2 minutes. This slight phase angle error can be tolerated within the working range of the instrument.

How this phase angle error will affect accuracy of wattage measurements is shown in Fig. 2. Because 2 minutes is too small to plot we have used a 5 degree error as an example. Such an error is not unknown in some commercial instruments. At or near 100% P.F. the 5 degree phase angle error in the instrument will give an actual error in the watt reading of only .4% and in many instruments even this 5 degree error could be tolerated for use on DC or AC at 100% P.F. loads only. If, however, that same error is encountered when reading watts at 50% P.F. loading it creates an error of 7.56% and at 20% P.F. the watt error is up to 8.59%.

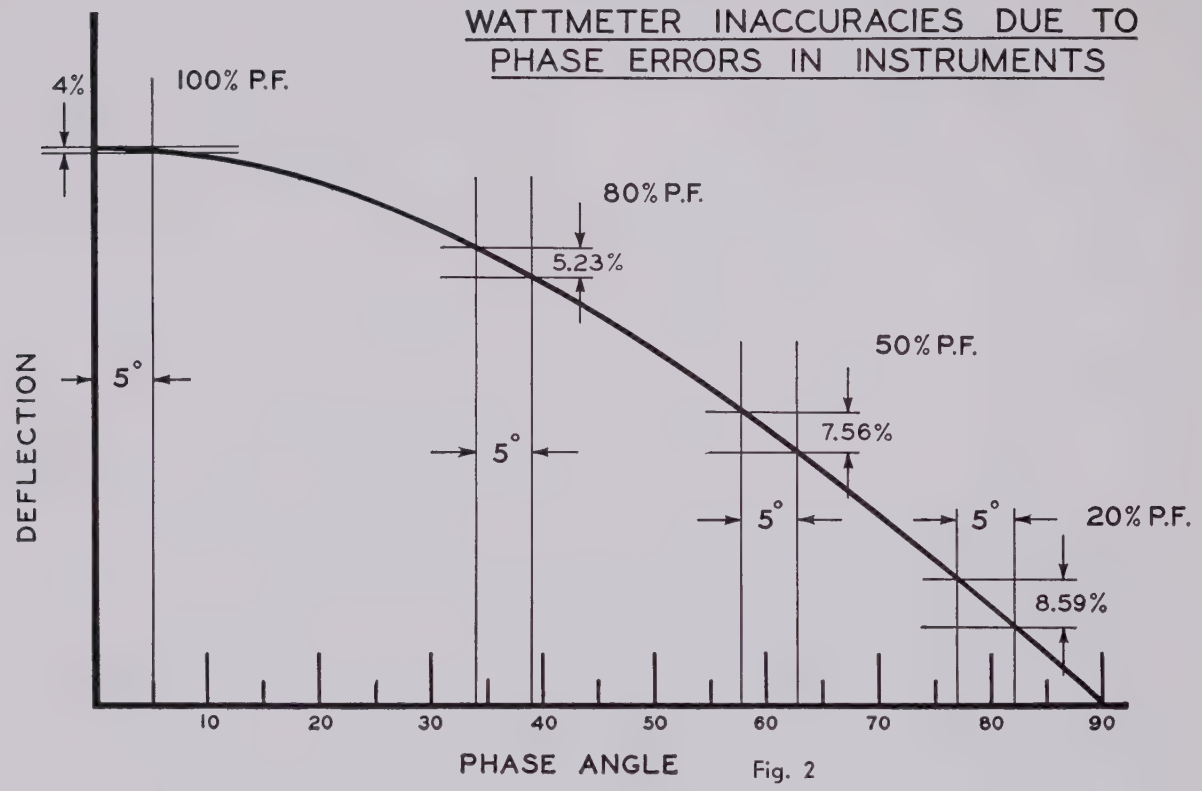


Fig. 2

The above figured diagram shows the extreme accuracy of phase angle adjustment required, if calibrations at other than near 100% power factor conditions are to be undertaken. It is extremely difficult to set a voltage and and a current exactly 60° out of phase to simulate a 50% load when we need an angular accuracy of ±2 minutes to guarantee accuracy. No good method exists of obtaining such accuracy. In fact, except as we have a perfectly sinusoidal wave for both voltage and current it is difficult to define the phase angle accurately. For a perfect sine wave we can use angular difference between zero axis crossings, between peaks or at some specific height and we arrive at a useable definition. In actual practice, where .1% accuracies are involved, it becomes difficult to maintain sinusoidal voltage and current sources with sufficient purity. It becomes even more difficult to evaluate what the effective phase angle actually is when either or both values are slightly non-sinusoidal. Under these conditions, zero axis crossing, peak, or crossing at a specific value may all give different angular values for the phase under the same set of conditions. An almost impossible situation arises in trying to actually set up fundamental wattmeter calibrations for other than 100% P.F. conditions.

All these troubles have led to a calibration method, which actually side-steps the difficulty rather than solving it.

In lieu of actual low power factor calibrations an A.C.-D.C. difference test is substituted. Such a test is made after D.C. calibration has shown satisfactory accuracy of the basic instrument. Use is made of a VERY SPECIAL WATTMETER in which regardless of efficiency, everything has been done to REDUCE phase angle errors to a minimum. This instrument has no metal supports, no shield (an astatic movement is used), multistrand Litz type coils, etc., every effort having been made to produce an error free movement as far as phase angle errors are concerned, and with good short term calibration stability. The instrument to be checked is compared to this "Standard" instrument on D.C. and its calibration noted. Both instruments are then changed to A.C. of approximately the desired power factor and the "Standard" assumed to have no phase errors is again compared to the test instrument. Any difference on A.C. which did not show on D.C. is assumed to be because of such errors occurring in the test instrument, and are reported as A.C.-D.C. differences at the specified frequency and power factor.

For the Model LW this means that the fundamental D.C. and (100% P.F.) A.C. calibration is guaranteed accurate within ± .1%. A.C.-D.C. difference tests are also made on each instrument and acceptable instruments will show errors equivalent to less than 5 minutes of phase angle at any point within its rated values.

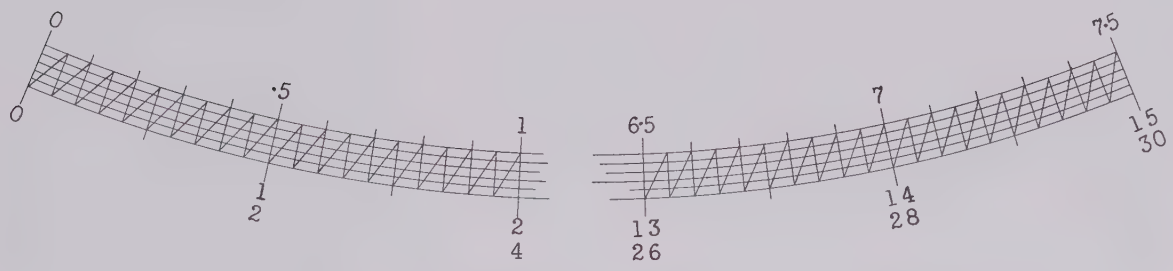
LABORATORY STANDARD DYNAMOMETER WATTMETER

MODEL **LW**

ACCURACY .1 OF 1%

SCALE LENGTH 12 INCHES

SIZE 16⅛ x 14¼ x 6¼ INCHES



SECTIONAL FULL SIZE PRECISION VERNIER OF 12 INCH SCALE

Our "one tenth of one per cent" Laboratory Standard wattmeters will be found extremely valuable in electrical measurement standardization work. They represent the finest of our instruments . . . finest as regards mechanical construction, accuracy, stability of component parts, readability and physical appearance. These desirable qualities may be attributed to the expert craftsmanship of our experienced instrument makers and the untiring efforts in design and development of our Engineering Department.

These instruments have been internationally accepted as ELECTRICAL MEASUREMENT STANDARDS for the past 31 years.

The instrument is supplied in a circassian walnut case. It has a highly polished black insulating panel. For best positioning if moved, we use screw leveling feet and a a bubble indicator. *"Diamond Pivots"* and shock mounted jewels are used exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. These pivots reduce the friction to a completely negligible level.

FOR USE ON DC AND 25 - 125 CYCLES AT POWER FACTORS DOWN TO 80%

Maximum volts are 75, 150 and 300 volts on all listed ranges.

WATT RANGES		CURRENT RANGES							
Series	Par.	Normal		Maximum		SCALE	RANGE		
Fields	Fields	Ser.	Par.	Ser.	Par.	Div.	*Printed	CODE	PRICE
25/50/100	50/100/200	.33	.66	.66	1.33	100	100	LWATTO	$1105.00
37.5/75/150	75/150/300	.5	1.0	1.0	2.0	150	75	LWATAM	1060.00
75/150/300	150/300/600	1	2	2	4	150	150	LWATER	1060.00
187.5/375/750	375/750/1500	2.5	5	5	10	150	750	LWATHY	1060.00
250/500/1000	500/1000/2000	3.33	6.66	6.66	13.33	100	1000	LWATIS	1060.00
375/750/1500	750/1500/3000	5	10	10	20	150	750	LWATJA	1060.00
500/1000/2000	1000/2000/4000	6.66	13.33	13.33	26.66	100	1000	LWATKO	1105.00
750/1500/3000	1500/3000/6000	10	20	20	40	150	1500	LWATLU	1210.00

Correspondence invited for wattmeters for use at other frequencies.

* At an additional cost of $100 the wattmeter can be furnished with dual scales and all ranges printed on the instrument scale.

Frequency compensated instruments for use at 380 to 420 cycles only at an additional cost of $100.

MODEL STC

The overall dimensions of the usual unmounted standard cell have remained unchanged for many years. Their large size of approximately 3¼ x 2⅜ inches requires considerable space for internal use in compact test assemblies.

Our standard cells are hermetically sealed and are only 1 inch wide and 3 inches long, making a very compact and satisfactory design. These cells are made for us by the well known "Eppley Laboratories" at Newport, Rhode Island. They are of the unsaturated cadmium type with a constant absolute voltage of between 1.0188 and 1.0198 volts. A statement of its absolute voltage accompanies each cell. Its internal resistance is below 1200 ohms. The temperature coefficient is —.00001 volt per degree Centigrade. Currents up to 10 microamperes may be drawn for short periods although 5 microamperes is considered the best maximum drain.

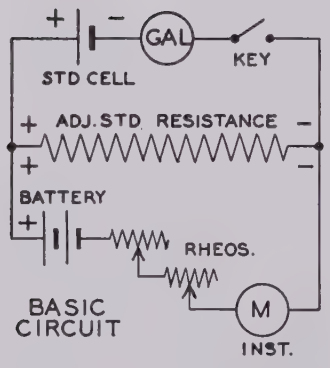
These cells may be used with potentiometers for measuring currents or voltage and also in circuits of the "NULL" balance type (see below).

Our cell is available in an internally insulated black moulded case or in an unmounted form for use in equipment by the purchaser. The unmounted cell should not be exposed continuously to a steady light. If the cell is inadvertently roughly handled, it should be allowed to stand at rest for a few hours for best accuracy.

STANDARD CELL
MOUNTED IN BLACK BAKELITE CASE
ACCURACY .025 OF 1%

DO NOT USE A VOLTMETER TO MEASURE ITS VOLTAGE. USE ONLY A PRECISION POTENTIOMETER.

A typical circuit for using a standard cell is shown below
(Incidentally, this is the circuit that is used in our Self-Checking instruments.)



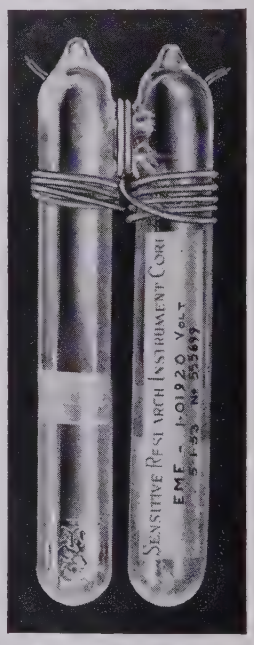
EXAMPLE

It is desired to certify an 0 - 10 microampere instrument. Knowing the voltage of the standard cell, for instance (1.0190 absolute volts), and using the circuit shown with a resistance of 101,900 ohms across the standard cell circuit, it will require an OPPOSING current of exactly 10 microamperes to balance the galvanometer.

Other points can be obtained quite readily. For instance, 8 microamperes by:

$$R = \frac{E}{I} \quad \text{or} \quad \frac{1.0190 \text{ Volts}}{.000008 \text{ Amperes}} = 127{,}375 \text{ ohms}$$

NOTE: If the volt drop resistance is so low as to draw more than 10 microamperes from the cell, then connect a current limiting resistance in series with the cell so as to avoid a current drain of over 10 microamperes.



ACTUAL FULL SIZE
UNMOUNTED CELL

SUPPLIED WITH ACCURACY CERTIFICATE FROM OUR LABORATORY

Absolute Volts	Type	Code	Price
1.0188 to 1.0198	Unmounted	STCUM	$20.00
	Mounted	STCOD	30.00
➔ For use with our Self Checking Instruments with all necessary resistances. Please give our instrument number when ordering.		DCSTCEL for DC Standard	50.00
		ACSTCEL for AC Standard	45.00

HISTORICAL

Since January 1st, 1947, new values to be known as "Absolute Values", replaced the older international values.

1 International Volt	=	1.000330 absolute volts
1 International Ampere	=	.999835 absolute ampere
1 International Ohm	=	1.000495 absolute ohms
1 International Watt	=	1.000165 absolute watts

Fourth Printing
Printed in U.S.A.

Prices and specifications subject to change without notice.

ARVA, INC. · Manufacturer's Representative
1320 Prospect Street · Seattle 9, Washington · MA 2-0177

REFERENCE STANDARD

PORTABLE and PANEL

DIRECT CURRENT INSTRUMENTS

MICROAMMETERS
MILLIAMMETERS
AMMETERS
MILLIVOLTMETERS
VOLTMETERS
KILOVOLTMETERS

MODELS

S	UP
HS	UPP
C	NP
N	DCHI
J	NPR
JW	UNIVERSITY

SENSITIVE RESEARCH INSTRUMENT CORPORATION

NEW ROCHELLE, NEW YORK.

Symbol of Quality

ELECTRICAL INSTRUMENTS OF PRECISION SINCE 1927

GENERAL DESCRIPTION AND SPECIFICATIONS OF D.C. INSTRUMENTS

The Models S, HS, C, J, UNIVERSITY and N comprise a line of portable precision DC microammeters, millammeters, ammeters, millivoltmeters, and voltmeters. The Models JW and JWSP, and the Models S, HS, and C when installed in a curved face type EW-5 or EW-7 case, are edgewise panel instruments with the same performance characteristics as the portables. The Models UP, UPP, NP, and NPR are rectangular, flat faced, panel instruments.

All SENSITIVE RESEARCH DC instruments feature a large U shaped magnet with an inherently high torque to weight ratio, stability and sensitivity.

GENERAL CONSTRUCTION AND PERFORMANCE CHARACTERISTICS

ASA SPECIFICATIONS – All instruments conform to ASA specification C-39.1 1959 for either .25% or .5% class portables.

TYPE – Double-pivoted D'arsonval.

MOVEMENT AND MAGNET – Large size formerless moving coil is light in weight and sturdy in construction. Magnet of Alnico 2 or 5 is engineered to give maximum flux density and stability. Unusual assembly guards against the possibility of long term drift.

PIVOTS AND JEWELS – All instruments normally contain the finest quality high carbon steel pivots and sapphire jewels. Where high sensitivity is necessary, DIAMOND PIVOTS and shock mounted jewels are furnished. Your specific attention is called to the Diamond Pivot which is available in any SENSITIVE RESEARCH instrument (if not already included in its specifications), at an additional charge of $30.00. This is a revolutionary development in pivot construction, pioneered by SENSITIVE RESEARCH's progressive engineering staff. The "Diamond Pivot" will withstand the tremendous impact of a 3-foot drop in an instrument without deformation of either pivot or jewel. Diamond Pivots are completely non-magnetic and free from hysteresis effects. They are ground to a minimum radius of .001. Their installation in indicating instruments assures the user of virtually "friction free" moving elements.

LEVELING – While these models are designed primarily for horizontal use, no precise leveling is necessary. It is recommended that they be used at no greater angle than 5° from the horizontal. Use of a horizontal type instrument at greater angles (dependent upon the sensitivity involved), reduces the repeatability of the instrument's indication due to pivot roll or spring sag.

SCALES – All SENSITIVE RESEARCH instruments are individually calibrated and their scales hand drawn. Scale plates are of heavy brass, and are finished in a durable white lacquer. (In maintenance and repair, the scale lines may be easily erased many times and redrawn on SRIC's precision, commercially available scale machine without damage to the scale plate.)

READABILITY – Instruments have knife-edge pointers and anti-parallax mirrors for maximum readability.

MAGNETIC AND ELECTROSTATIC SHIELDING – Most instruments contain magnetic and electrostatic shielding in conformance with ASA specifications. Magnetic shielding is not available in instruments with a sensitivity of 5 microamperes or below, or 200,000 ohms per volt and higher.

TEMPERATURE EFFECTS – Most instruments can be considered temperature compensated between 20°C and 30°C. Current and voltage measuring instruments have a temperature coefficient of .02% per degree centigrade or less. High sensitivity millivoltmeters tend to a somewhat higher temperature coefficient. Reference temperature is 25°C. This information is contained on a data card attached to the individual instrument. A temperature correction factor is given.

SWITCH CONTROLS – All three or more range instruments are normally supplied switch controlled. Good instrumentation design requires that ranges of 3 amperes or higher, and 5 millivolts or less have separate binding posts. If binding posts only are desired, they can be substituted for the switch at no extra cost.

DAMPING – Accomplished by the use of eddy currents in the moving coil, or shunting by external resistance.

ZERO ADJUSTMENT – A manually controlled external zero shifter is standard in every instrument.

MAGNETIC SHUNT – Internal adjustable magnetic shunts are standard on all DC instruments. Maximum adjustment is 1.5% of full scale.

POLEPIECES – The polepieces are diecast as a single unit. The magnetic field in the air gap is, therefore, both stable and uniform.

REPAIR SERVICE – The design of SENSITIVE RESEARCH's moving elements facilitates maintenance in the field. A repair training school is available at no charge to users of SENSITIVE RESEARCH instruments. Write for additional details.

Should an instrument arrive accidentally damaged in transit, it must be examined in the original container by the carrier and a joint inspection report filed.

PORTABLE FORMICA CASE

The Model S is available as an edgewise panel instrument in the type EW-5 and EW-7. See page 215 for specifications.

LOW RESISTANCE DESIGN—Ranges of 15 microamperes or under have a 5.2" scale length. Ranges below 5 microamperes have an accuracy of 1%. All ranges supplied with Diamond Pivots and shock mounted jewels.

HIGH RESISTANCE DESIGN — Ranges below 5 microamperes have a 5.2" scale length and an accuracy of 1%. Diamond Pivots and shock mounted jewels are standard on all ranges.

MODEL S

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100 or 150
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring mounted
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	7½" x 7¾" x 4¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

Our model S instruments, introduced to the engineering profession 33 years ago, are being used in practically every important research laboratory in this country and abroad. They comprise a complete line of high sensitivity DC precision Microammeters, Milliammeters, Voltmeters and Millivoltmeters.

"Diamond Pivots" and shock mounted jewels are used exclusively in these instruments. This is a revolutionary development in pivot construction, pioneered by our progressive engineering staff. These pivots reduce bearing friction to a completely negligible level. Diamond Pivots will withstand the tremendous impact of a three foot drop without deformation of either the pivot or jewel.

These instruments have highly polished black moulded panels, with insulated binding posts, switch knobs, etc. The formica case is equipped with slip hinges. The metal fittings are of chrome plated brass and the case has a substantial carrying strap.

SINGLE RANGE

HIGH Resistance Design

Full Scale Microamps	Scale Division	Code Word	Approx. Res. Ohms	Price Portable
*1	100	SXICSEN	18000	$315.00
*1.5	75	SXICAII	10000	280.00
*2	100	SXICOTA	9800	245.00
*5	100	SXICAMP	9800	225.00
10	100	SXICENT	9500	185.00
15	150	SXICILO	9500	180.00
20	100	SXICOPT	2550	180.00
30	150	SXICROT	1800	175.00
50	100	SXICAPS	1050	175.00
100	100	SXICERO	590	165.00
150	150	SXICIKA	235	165.00
200	100	SXICORT	165	165.00
300	150	SXICUBE	75	165.00
500	100	SXICADE	50	165.00
1000	100	SXICEKT	40	165.00

*NOT magnetically shielded in these sensitivities.

Low resistance instruments should be used in circuits where there is only a small amount of energy available.

Ranges of 10 microamperes and above in HIGH RESISTANCE design ONLY can be supplied in EW-7 case with 7.0" scale length.

LOW Resistance Design

Full Scale Microamps	Scale Division	Approx. Res. Ohms	Code Word	Price Portable
*2	100	6500	SICOTA	$270.00
*5	100	4000	SICAMP	250.00
10	100	3750	SICENT	235.00
15	150	2600	SICILO	230.00
20	100	280	SICOPT	230.00
30	150	150	SICROT	225.00
50	100	100	SICAPS	225.00
100	100	50	SICERO	215.00
150	150	30	SICIKA	215.00
200	100	10	SICORT	215.00
300	150	7.5	SICUBE	215.00
500	100	5	SICADE	215.00
1000	100	2	SICEKT	215.00

FORMICA CASES, we believe, are the finest in "the state of the art." They are structurally strong, dimensionally stable, and extremely resistant to deterioration from rough handling or adverse environmenal conditions. In addition, they are furnished with a fitted panel gasket, which serves as an effective dust seal. The formica case itself is a good humidity BARRIER. The finish of any formica case wil be like "new" even though subjected to the severest usage.

MULTIRANGE DIRECT CURRENT MICROAMMETERS & MILLIAMMETERS

MODEL S

TRIPLE RANGE

HIGH Resistance Design

Full Scale Microamperes	Approx. Res. Ohms	Code Word	Price
** 1/5/10	15000/320000/180000	SXICCI	$365.00
**2.5/10/50	11000/135000/28500	SXICTO	284.00
** 3/15/75	10900/80400/18200	SXICDA	274.00
** 3/30/300	10900/45100/4950	SXICHI	274.00
** 5/20/100	10860/75700/19000	SXICJO	261.00
** 5/50/500	10860/32200/3960	SXICKU	261.00
10/50/100	6750/32250/19050	SXICLA	223.00
10/100/1000	6750/18050/1980	SXICMI	223.00

LOW Resistance Design

Approx. Res. Ohms	Code Word	Price
**7000/38600/9200	SICDA	$297.00
**7000/22600/2370	SICHI	297.00
**5950/15900/4640	SICJO	291.00
**5950/13500/980	SICKU	291.00
2870/6500/3630	SICLA	276.00
2870/3630/396	SICMI	276.00

FOR PANEL TYPE EW-5 AND EW-7 CASES, SEE PAGE 215 FOR SPECIFICATIONS
ADD $20.00 TO LISTED PRICES FOR EW-5 CASE (All Ranges) AND $25.00 FOR EW-7 CASE (High Resistance Design from 10 Microamperes and Up.)

PHOTO CELL MICROAMMETERS

Full Scale Microamperes	Resist. All Ranges	Code Word	Price
20/50/100/200/500/1000	1050	PHORCA	$346.00
50/100/200/500/1000	100	PHOTOX	330.00

Supplied with Diamond Pivots, Magnetically Shielded and 5.2" scale.

LOW RESISTANCE DESIGN—Ranges of 15 microamperes or under have a 5.2" scale. Ranges below 5 microamperes have an accuracy of 1%. All ranges supplied with Diamond Pivots and shock mounted jewels.

HIGH RESISTANCE DESIGN — Ranges below 5 microamperes have a 5.2" scale length and an accuracy of 1%. Diamond Pivots and shock mounted jewels are standard for all ranges.

MULTIRANGE D.C. MILLIAMMETERS

We are advocates of the multirange instrument. When considering the cost of a single range instrument, it will be worth remembering that for an additional few dollars, a multirange, more flexible instrument, may be obtained which will help considerably to reduce future laboratory costs.

The use of the Ayrton type shunt on high sensitivity instruments is necessary in order to achieve uniform damping and a satisfactory temperature coefficient. This shunt is usually ten or more times the resistance of the moving element and will very often cause the second and third lowest range values to be greater in resistance than the most sensitive range.

All multirange instruments are supplied switch controlled.

HIGH Resistance Design

Full Scale Milliamperes	• Approx. Res. Ohms	Code Word	Price
**.0025/.005/.01/.025/.05/.1/.5/1	11M/153M/135M/54M/28.5M/14650/2985/1500	SXILSA	$351.00
**.003/.03/.3/3/30	10900/45100/4950/500/50	SXILBO	309.00
**.004/.04/.4/4/40	10860/36600/3960/398/40	SXILCU	303.00
**.005/.02/.1/.5/2/10	10800/75700/19000/3960/998/200	SXILDA	303.00
.01/.05/.1/.5/1/5/10/50	6750/32250/18000/3925/1980/988/200	SXILFI	285.00
.01/.1/1/10/100/1000	6750/18000/1980/200/20/2	SXILIT	265.00
.02/.2/2/20/200	2860/5425/594/60/6	SXILKA	241.00
.03/.3/3/30/300	2530/3630/396/40/4	SXILMO	241.00
.05/.1/.5/1/5/10/50/100	1350/7830/2710/1430/290/150/30/15	SXILNI	275.00
.05/.5/5/50/500	1350/2710/290/30/3	SXILOT	241.00
.1/1/10/100/1000	830/1350/140/15/1.5	SXILPU	241.00
.1/.5/1/5/10/50/100/500	830/2450/1350/298/140/30/15/3	SXILRA	275.00
.2/2/20/200	85/37/3.9/.4	SXILUV	231.00
.5/5/50/500	45/27/2.5/.3	SXILIV	231.00
.5/2/10/50/200/1000	45/60/14/3/.75/.15	SXILXY	247.00

• M = 1000

LOW Resistance Design

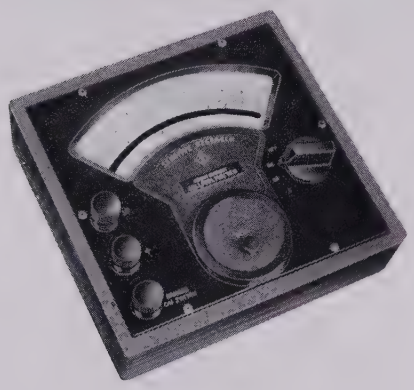
Approx. Res. Ohms	Code Word	Price
**7000/22600/2370/240/24	SILBO	$332.00
**5350/9059/990/100/10	SILCU	326.00
**5950/15900/4640/980/375/75	SILDA	326.00
2870/6510/3630/785/396/200/40	SILFI	328.00
2870/3630/396/40/4/.4	SILIT	308.00
1000/1000/109/11/1.1	SILKA	289.00
1000/1000/109/11/1.1	SILMO	289.00
235/2810/992/524/109/55/11/5.5	SILNI	325.00
235/992/109/11/1.1	SILOT	289.00
*50/50/5.5/.55/.055	SILPU	289.00
*50/90/50/11/5.5/1.1/.55/.11	SILRA	325.00
*10/10/10/10 (Constant Res.)	SILUV	294.00
10/10/1.1/.11	SILIV	279.00
10/21/5.2/1.1/.27/.055	SILXY	295.00

*The bottom range of the LOW RESISTANCE designs is suitable for use with our vacuum thermocouple for AC and radio frequency measurements.

** NOT magnetically shielded on these high sensitivities.

UNLESS SPECIFICALLY ORDERED, THE HIGH RESISTANCE TYPE WILL BE SUPPLIED.

MODEL S



A BENCH TYPE CASE, as pictured above, can be supplied, if specified, at no extra cost. The case is furnished without a cover or leather carrying strap.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100 or 150
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring mounted
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	7½" x 7¾" x 4¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

Millivoltmeters can be furnished, at no extra charge, with their scales marked in AMPERES. Either a 100 or 150 scale division must be specified. A double scale can be provided printed 0 - 100 and 0 - 150, at an additional cost of $20.00.

Add $5.00 for each extra row of printing. A maximum of 4 rows of printing may be obtained.

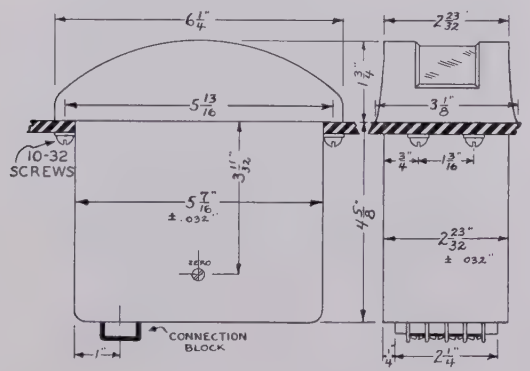
	Full Scale Millivolts		Resistance Ohms	Code Word	Price
	1	5.2" scale	5	SMVMA	$210.00
	2		10	SMVPU	195.00
	5		25	SMVSI	195.00
	10		50	SMVTA	195.00
➔	50		250	SMVVO	185.00
➔	100		500	SMVBU	185.00
➔	50-0-50		500	SMVKI	185.00
➔	100-0-100		1000	SMVRU	185.00

➔ These millivoltmeters recommended for use with external current shunts (see index). They are automatically conmpensated for ambient room temperature changes from 15°C. to 30°C. All Model S. millivoltmeters are supplied with 5 feet, .026 ohm calibrated leads and have their potential drop taken at the end of the leads. If leads are not desired, deduct $5.00.

MULTIRANGE

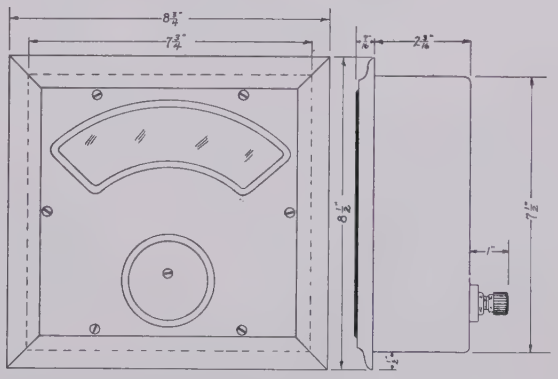
**3/10	10 ohms (both ranges).		SMVLA	$245.00
1/5/20/50	5.2" scale.	.5/25/100/250	SMVLE	252.00
1/10/100/1000	5.2" scale.	.5/50/500/5000	SMVLI	252.00
1.5/7.5/15/30/75	5.2" scale.	.7.5/37.5/75/150/375	SMVLO	257.00
2/5/10/20/50/100		.10/25/50/100/250/500	SMVLU	275.00
2/20/200/2000		.10/100/1000/10000	SMVLY	252.00

**For vacuum thermo couple work special attention is called to the two range, 3/10 millivoltmeter, code SMVLA, having a constant resistance of 10 ohms.



EW5 SHALLOW CASE

FOR MODELS S, A, HS, MI, FS, FM, SD, RA, FRE, AU, XT AND FLV



Models S, HS and C instruments can be supplied in cases designed for flush bench mounting with binding posts on the bottom, at an additional charge of $10.

HIGH RESISTANCE D. C. VOLTMETERS

MODEL S

These high resistance Model "S" Voltmeters are supplied in sensitivities of from 1000 ohms per volt up to 50,000 *ohms per volt. Their low current drain makes them particularly adaptable for all types of radio and electronic laboratory work because measurements of plate, screen, cathode and, to a certain extent, grid voltages may be made with a minimum upsetting effect on the electronic circuit.

EW type edgewise panel instruments may be obtained with up to 8 ranges, internally switch controlled. If an instrument is selected with a greater number of ranges, they must be put on binding posts. Please specify which are NOT to be switch controlled.

FOR EW-7 PANEL CASE, ADD $25.00 TO LISTED PRICES

FOR EW-5 PANEL CASE, ADD $20.00 TO LISTED PRICES

(See page 215)

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100 or 150
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring mounted
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	7½" x 7¾" x 4¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

*For higher "ohms per volt" instruments please see our Model HS listings on page 207. Special high resistance zero center instruments are listed for corrosion testing.

SINGLE RANGE

Full Scale Volts	Code	PRICES 1000 Ohms per Volt	5000 Ohms per Volt	10,000 Ohms per Volt	20,000 Ohms per Volt	50,000 Ohms per Volt
.5	SOLVA	$170.00	$180.00	$190.00	$200.00	$210.00
1.5	SOLAK	170.00	180.00	190.00	200.00	210.00
3	SOLEM	170.00	180.00	190.00	200.00	210.00
10	SOLIT	170.00	180.00	190.00	200.00	210.00
30	SOLOR	172.00	185.00	200.00	210.00	215.00
50	SOLUS	175.00	195.00	205.00	225.00	230.00
150	SOLKA	180.00	200.00	215.00	230.00	—
300	SOLDA	185.00	205.00	222.00	—	—
750	SOLDU	190.00	212.00	232.00	—	—
1500	SOLBI	200.00	225.00	255.00	—	—

MULTIRANGE

10,000 OHMS PER VOLT

Full Scale Volts	Code	Price
1.5/3/7.5/15/30/75/150/300/750	SOLBEK	$325.00
2/5/10/20/50/100/200/500	SOLCAK	325.00
10/50/100/200/500/1000	SOLDOK	325.00
15/30/75/150/300/750/1500	SOLFAP	345.00

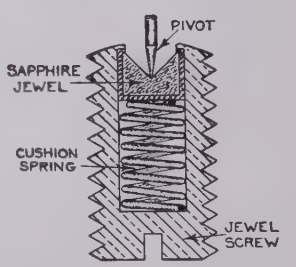
Special "Zero Center" Voltmeter

.5/2/5/20/50/200/500 millivolts/2/5/20/50/200 volts

10,000 ohms per volt.....Code **SOLSEN**.....Price $395.00

Supplied with calibrated 5', .026 ohm leads.

SHOCK MOUNTED JEWEL



STANDARD IN ALL INSTRUMENTS OF HIGH SENSITIVITY

MODEL HS

UP TO 1,000,000 OHMS PER VOLT!

FITTED IN FORMICA CASE

Certain types of measurements require **high** resistance D.C. Voltmeters. This is true particularly in electrolysis, insulation resistance measurements and tube bias circuits.

The instruments listed below represent the very highest obtainable sensitivity in *portable* D.C. Voltmeters available today.

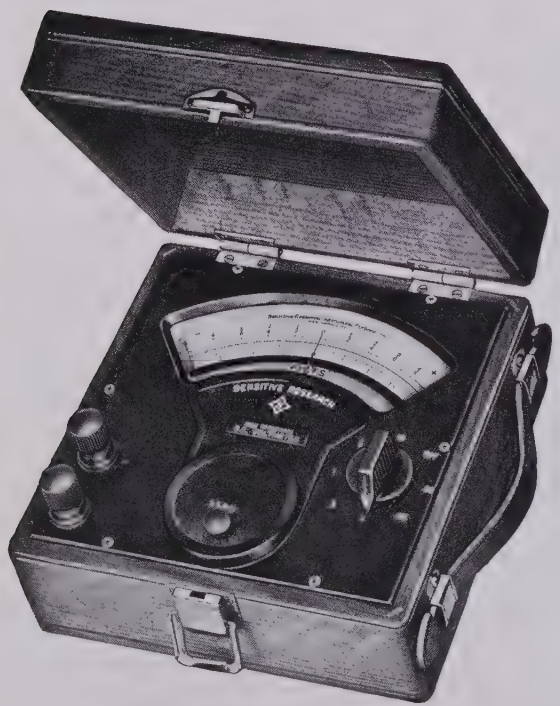
These rugged, portable double-pivoted voltmeters are the ideal instrument for electrolysis measurements where it is desired to measure voltages at sensitivities up to 1,000,000 ohms per volt. They have 6.3 inch, 100 division scales and are exceptionally useful for field or manhole work as they require *no precise leveling*. They are fitted with a click position selector switch for changing the ranges.

These instruments have moulded engraved bakelite panels, fitted with insulated binding posts, switch knobs, etc. The cases have slip off hinges on the cover with a substantial carrying strap and all the metal fittings are of chrome plated brass.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	See below
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100
PERIOD	3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	7½" x 7¾" x 4¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds



Unusually high insulation is used on 500,000 and 1,000,000 ohms per volt instruments.

Accuracy Guarantee

1% on sensitivities above 200,000 ohms per volt
.5 of 1% on sensitivities of or below 200,000 ohms per volt

"ZERO LEFT" INSTRUMENTS

Full Scale Volts	Code	Ohms Per Volt	Price
.005/.02/.1/.5/2/5/20/50/100	HIVOTO	10,000 ohms/v	$317.00
.02/.05/.1/.2/1/5/20/50	HIVOSP	50,000 ohms/v	326.00
.05/.1/.5/1/5/10	HIVOOM	100,000 ohms/v	333.00
.05/.1/.5/1/5/10	HIVOOM	200,000 ohms/v	348.00
.05/.1/.5/1/5/10	HIVOOM	500,000 ohms/v	359.00
.05/.1/.5/1/5/10	HIVOOM	*1,000,000 ohms/v	408.00

Polarity reversing switches also available, add $25 to prices.

"ZERO CENTER" INSTRUMENTS

Full Scale Volts	Code	Ohms Per Volt	Price
.005/.02/.1/.5/2/5/20/50/100	HIVOCK	20,000 ohms/v	$317.00
.02/.05/.1/.2/1/5/10	HIVOLT	200,000 ohms/v	338.00
.05/.1/.5/1/5/10	HIZOZA	200,000 ohms/v	338.00
.05/.1/.5/1/5/10	HIZOZA	500,000 ohms/v	343.00
.05/.1/.5/1/5/10	HIZOZA	*1,000,000 ohms/v	369.00

Code

*.001/.0025/.005/.01/.025/.05/.1/.25/.5/1/2.5 ..AMWEST.. Price $530.00

10,000 ohms per volt up to and including .01 volt. Approx. 200,000 ohms per volt on all other ranges. Leads included

Higher voltage ranges available, correspondence solicited.

*Scale length 5.2". NOT Magnetically Shielded.

MODEL C

FAST IN ACTION!

REQUIRES NO PRECISE LEVELING!

The Model C type of instrument is designed for general testing where an accurate rugged, short period instrument is desired for the shop, laboratory or field as a **REFERENCE STANDARD.** These instruments will stand severe handling and overloading. They are mounted in sturdy Formica cases.

Correct proportioning of a high torque-weight ratio movement, together with the use of light weight metals, result in a very small moment of inertia, causing the pointer to follow faithfully slight or rapid changes in the circuit under measurement.

The Model C can be furnished as an edgewise panel instrument with no loss of accuracy or deviation in general performance characteristics. When mounted in the Type EW-7 case (illustrated above) it has a 7" hand drawn mirrored scale. When ordering specify the Model CEW-7 and add $25.00 to the price of the portable model.

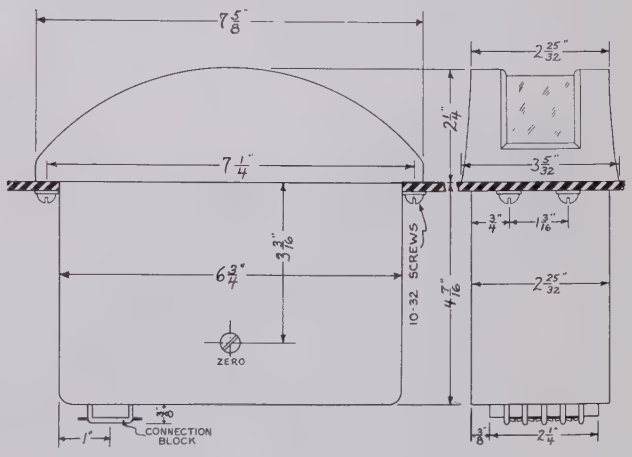
The Model CEW-5 has a 5" scale length and is available at an additional charge of $20.00. The Type EW-5 case (shallow) is illustrated on page 215.

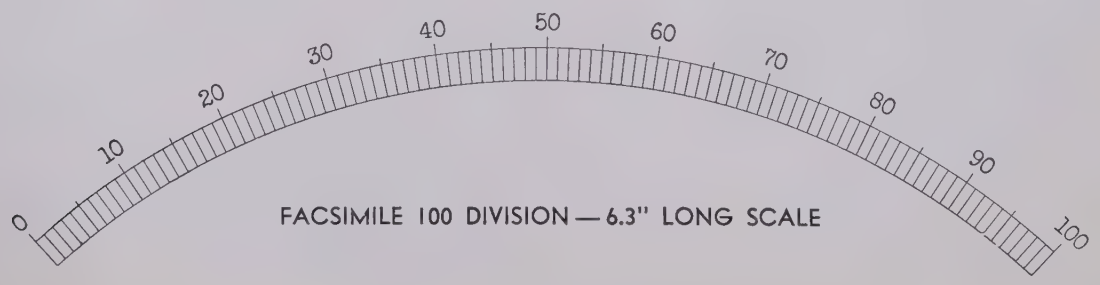
SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.25 of 1% in horizontal position
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100 or 150
PERIOD	1 second
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	7½" x 7¾" x 4¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

SPECIFICATIONS FOR TYPE EW-7 SHALLOW CASE





FACSIMILE 100 DIVISION — 6.3" LONG SCALE

PORTABLE REFERENCE STANDARD D.C. MICRO-MILLIAMMETERS

MODEL C

ACCURACY IN HORIZONTAL POSITION .25 OF 1%
MAGNETICALLY SHIELDED

MICRO-MILLIAMMETERS

Full Scale Microamperes	Scale Divisions	Approx. Resistance Ohms	Code	Price Portable
30	150	12000	CICIK	$200.00
50	100	5800	CICAM	195.00
100	100	3750	CICOL	190.00
200	100	800	CICMO	190.00
500	100	100	CICET	190.00

Full Scale Ranges In Milliamperes				
1	100	100	CILEL	$175.00
3	150	70	CILIP	175.00
5	100	40	CILOP	175.00
7.5	150	28	CILUK	175.00
10	100	20	CILAS	175.00
15	150	15	CILTO	175.00
30	150	10	CILKY	175.00
50	100	1.5	CILCA	175.00
100	100	.50	CILDI	175.00
200	100	.25	CILFO	175.00
300	150	.15	CILHU	175.00
500	100	.10	CILLE	175.00
750	150	.05	CILPY	175.00

MULTIRANGE

Full Scale Milliamperes	Approximate Resistance in Ohms	Code	Price Portable
.05/.1/.5/1/5/10/50/100	6200/16700/5460/2860/594/298/60/30	CILKI	$288.00
1.5/7.5/30/150	88/123/36/7.5	CILBRA	237.00
3/15/75/150	45/82/20/10	CILCOT	237.00
5/10/50/200	44/98/32/9	CILDEN	237.00
10/50/200/500	13/17/4.7/1.9	CILENT	237.00
15/75/300/750	11/8.4/2.5/1	CILFOR	237.00
50/200/500/1000	2.2/.7/.5/.3	CILHAT	237.00
150/300/750/1500	2/1/.4/.2	CILIST	237.00
#1.5/3/7.5/15/30/75/150/300/750/1500	88/210/123/72/36/15/7.4/3.7/1.5/.75	CILPOL	293.00
#2/5/10/20/50/100/200/500/1000	86/158/99/55/23/12/6/2.4/1.2	CILMUL	283.00

Multirange instruments have selector switches

#Up to 8 ranges only on switch in EW-7 case. Remaining ranges on binding posts in rear of case.

D C AMMETERS

Single Range

Range Amperes	Scale Divisions	Code	PRICE	Range Amperes	Scale Divisions	Code	PRICE
1	100	CAMIT	$180.00	10	100	CAMBI	$187.00
1.5	150	CAMEL	180.00	15	150	CAMPA	187.00
3	150	CAMAT	180.00	20	100	CAMBRA	187.00
5	100	CAMOS	180.00	30	150	CAMFU	190.00
7.5	150	CAMUK	182.00	50	100	CAMJI	194.00

All the above instruments have permanently attached shunts.

MILLIVOLTMETERS

Full Scale Millivolts	Code	Resistance Ohms	PRICE
50	CMVTA	12.5	$190.00
100	CMVTU	25	190.00
50/100	CMVPO	12.5/25	202.00

Above millivoltmeters are recommended for use with external shunts.
Two 5 ft. (.026 ohm) leads are supplied with above instruments.

Normally supplied with 100 or 150 division scale. If dual scale is desired, add $20.00 to listed price. Scale marked in AMPERES at no extra charge but this must be specified at time of ordering. Additional rows of numerals are available at $5.00 each. A maximum of 4 rows of numerals may be printed on a scale.

For EW-7 panel mounting case, add $25.00 to above prices.

See dimensions, page 215.

PORTABLE REFERENCE STANDARD D.C. VOLTMETERS

MODEL C

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.25 of 1% in horizontal position
SCALE LENGTH	6.3 inches
SCALE DIVISIONS	100 or 150
PERIOD	1 second
TYPE	D'Arsonval Double Pivot
PIVOTS	Diamond
JEWELS	Sapphire spring mounted
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	7½" x 7¾" x 4¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

PORTABLE FORMICA CASE WITH SLIP COVER

This instrument is a rugged, fast period D.C. Voltmeter having a resistance of 1000 or 5000 ohms per volt. Its light weight, high torque movement will faithfully follow small or rapid changes of voltage. Its heat dissipation is in milliwatts and it may therefore be left in its circuit continuously. Its temperature coefficient is negligible over a wide range of ambient temperature. The series resistances are of well aged double silk manganin wire, silver soldered to copper leads, and wound on lava resistance bobbin forms. All resistances are temperature cycled for stabilization purposes before their final adjustment.

SINGLE RANGE

Full Scale Volts	Scale Divisions	Code Word	PRICES Ohms Per Volt 1000	5000
1	100	COLED	$176.00	$186.00
3	150	COLOG	176.00	186.00
10	100	COLBA	176.00	186.00
15	150	COLJY	176.00	186.00
50	100	COLFU	180.00	200.00
100	100	COLGY	182.00	202.00
150	150	COLHO	185.00	205.00
300	150	COLKI	190.00	210.00
500	100	COLLY	193.00	213.00
750	150	COLMO	196.00	218.00
1000	100	COLNI	200.00	222.00
1500	150	COLPA	206.00	231.00

For EW-7 panel mounting cases add $25.00 to list prices.

For EW-5 Case—add $20.00.

See page 215.

All edgewise panel instruments have hand drawn mirrored scales. Their accuracy and performance characteristics are identical to the portable models.

MULTIRANGE VOLTMETERS

Full Scale Volts	Scale Divisions	Code Word	PRICES Ohms Per Volt 1000	5000
1.5/7.5/30/150	150	COLRA	$232.00	$242.00
2/10/50/200	100	COLST	232.00	242.00
3/15/75/300	150	COLTO	235.00	245.00
5/20/100/500	100	COLVY	240.00	252.00
10/50/200/500	100	COLWU	240.00	252.00
15/75/300/750	150	COLZO	247.00	262.00

THE RANGES BELOW ARE RECOMMENDED AS ALL PURPOSE INSTRUMENTS

1.5/3/7.5/15/30/75/150/300/750	150	COLPOL	1000 ohms per volt only	$302.00
2/5/10/20/50/100/200/500/1000	100	COLMUL	1000 ohms per volt only	307.00

All of above units fitted with selector switches. In edgewise panel case, up to 8 ranges only on switch.

DEFINITION OF INSTRUMENT ACCURACY ON LINEAR SCALE INSTRUMENTS

For many years it has been standard practice for electrical measuring instrument manufacturers to state instrument accuracy in terms of a percentage of the FULL SCALE value.

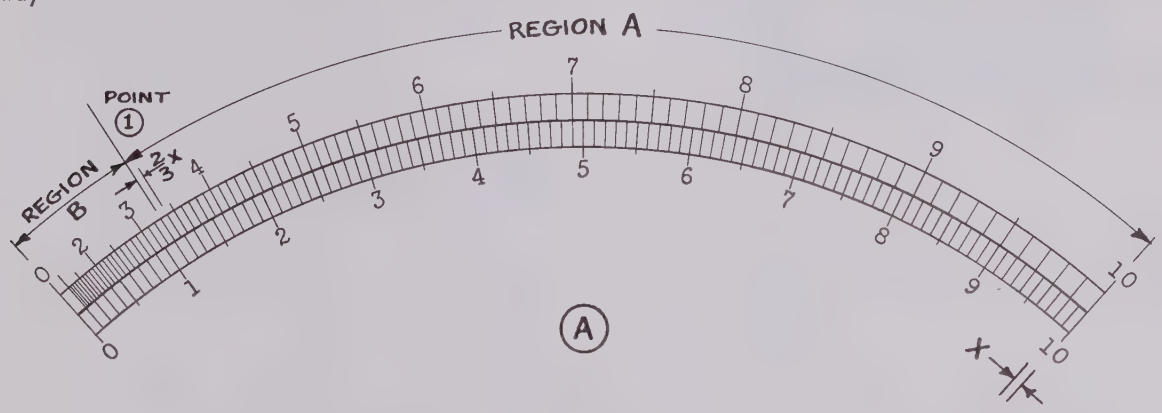
This is a necessary simplification of procedure as errors due to pointer thickness, graduation width and visual reading error are of a definite amount regardless of position on the scale. Therefore error expressed in terms of a percentage of the reading would be a *variable* depending on the position of the scale in use.

This makes it inconvenient to express error except in terms of PERCENTAGE OF FULL SCALE which is, of course, a constant AMOUNT throughout the scale. For example: a 100 volt instrument guaranteed to ¼ of 1% accuracy will have an allowable error of .25 volt at ANY POINT on its scale. Therefore to have a PRACTICAL system of expressing instrument accuracies, they are always understood to be in percentage of FULL SCALE readings.

For center zero instruments, the guaranteed accuracy is expressed in a percentage of the "left and right" full scale values.

NONLINEAR SCALE INSTRUMENTS

For nonlinear scale instruments, such as thermal instruments, dynamometer instruments and similar types, the per cent of full scale definition of accuracy has to be modified. The American Standard Association specification is stated this way —



"The stated accuracy only applies in those portions of the scale where the divisions are equal to or GREATER than two-thirds the width they would be if the scale were evenly divided. In other portions of the scale, the allowable limit of error will be a distance equal to two-thirds the total scale length multiplied by the rated accuracy (expressed as a decimal)."

To illustrate just what this definition of accuracy means, examine Figure A., Upper Scale. We show a non-linear scale in which the divisions grow progressively smaller as they approach zero. At some point on this type of scale, (Point (1) on Figure A) the scale divisions will have diminished in width until they are ⅔ the size of those on a linear scale. (Lower Scale.)

For non-linear scales, above and below this point they actually have two different definitions of accuracy. In the Region A above the point where the ⅔ size division occurred, the accuracy is a direct percentage of the full scale reading. Simplifying further, and assuming full scale equal to 10, for a ½% accuracy instrument, the accuracy at any point in Region A only, is ± ½ of one division regardless of the size of that division.

When we consider Region B of the scale, they change the definition of accuracy to a fixed scale distance rather than having the accuracy related to the constantly changing divisions. In this Region (B) the accuracy is defined as an exact allowable mechanical deviation rather than a percent of a division. This allowable deviation is taken to be the same mechanical error as is allowed at point (1), regardless of how large this may be in terms of the electrical quantities involved.

In summary then, throughout Region A we are allowed a fixed percentage of the electrical full scale value being measured, while throughout Region B we have a fixed mechanical amount of error allowed regardless of the electrical quantities involved.

EXAMPLE:

In the above illustration, in which are drawn two scales and assuming a ½% instrument, the division on the nonlinear scale which is ⅔ the size of one of the linear divisions, is at 33 divisions (3.3 reading). Thus, on this scale the guaranteed accuracy would be ½% of the full scale value for readings from 3.3 to 10. From 3.3 down to zero, the accuracy is .005 x 6.3" x ⅔ = .02". That is, the pointer will be within .02 inch of the correct position rather than an exact percentage of the full scale value read (assuming a 6.3 inch scale length).

MODEL J

High Sensitivity!

Our model J instrument is suitable for general use where a rugged, **COMPACT**, accurate and exceptionally sensitive instrument is desired. The movement is of our proven double pivot design similar to that used in our large Model S instruments.

SPECIFICATIONS

HORIZONTAL USE ONLY

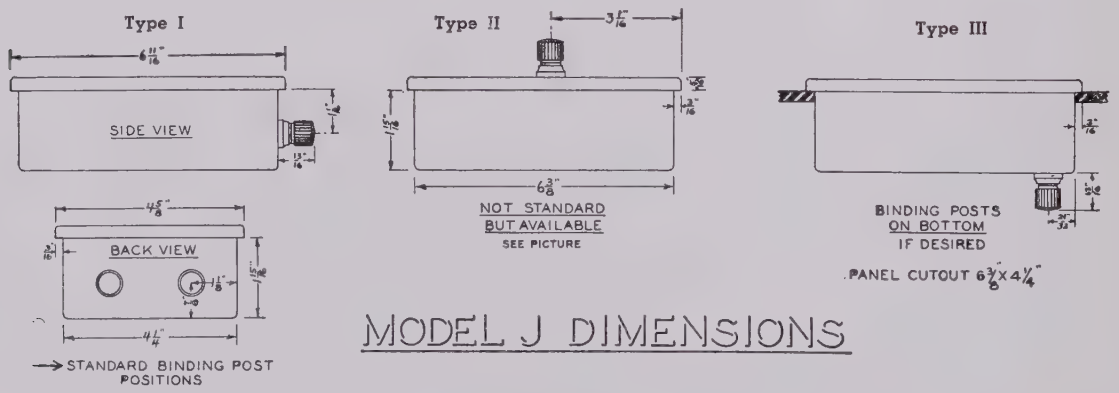
ACCURACY	.5 of 1%
SCALE LENGTH	3¼ inches
SCALE DIVISIONS	50 to 75
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Highly polished steel
JEWELS	Sapphire
SHIELDING	Electrostatic
CASE	Moulded bakelite
SIZE	6¼" x 4¼" x 2"
INST. WEIGHT	3½ pounds
SHIP. WEIGHT	8 pounds

IF DIAMOND PIVOTS ARE REQUIRED
ADD $30.00 TO LIST PRICE

Normally it is equipped with binding posts on the back (type I) but can also be supplied for flush mounting (see illustration below). Please state where binding posts are required.

Binding posts can be fitted either on back, top or on bottom of case at no extra cost. Specify type I, II, or III mounting as per diagrams.

BINDING POST MOUNTING POSITIONS



MODEL J DIMENSIONS

SINGLE RANGE

HIGH Resistance Design

Full Scale Microamperes	Resistance Ohms	Code Word	PRICE
†* 1.5	8000	JICII	$175.00
†* 1	8000	JICEE	145.00
†* 2	7000	JICIP	135.00
3	7000	JICLA	123.00
5	7000	JICMO	117.00
10	1400	JICNU	112.00
15	900	JICOO	107.00
20	440	JICRI	107.00

*Accuracy 1% at these high sensitivities!

†Includes Diamond Pivots

LOW Resistance Design

Full Scale Microamperes	Resistance Ohms	Code Word	PRICE
† 5	2700	JICAA	$138.00
† 10	900	JICBC	132.00
† 15	150	JICPY	130.00
† 20	100	JICEF	125.00
† 25	50	JICGM	125.00
30	50	JICVU	110.00
50	20	JICHI	110.00
100	5	JICCI	110.00

Certain measurements require a very low resistance microammeter of high sensitivity.

MODEL J
MULTIRANGE

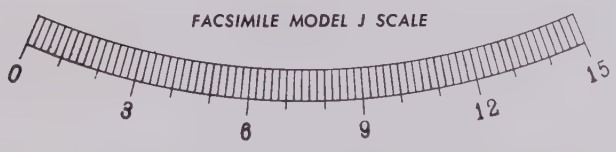
*HIGH RESISTANCE DESIGN

Full Scale Microamps	Approx. Resistance Ohms	Code	Price
2.5/10/50	6000/60000/13500	JXICSOL	$161.00
5/25/100	5800/37000/11750	JXICDOG	154.00
5/50/500	5800/22000/2350	JXICBIP	154.00
10/100/1000	4480/9000/998	JXICERB	139.00

•LOW RESISTANCE DESIGN

Full Scale Microamps	Approx. Resistance Ohms	Code	Price
5/25/100	4800/22000/5000	JICDOG	$165.00
5/50/500	4800/9900/1000	JICBIP	165.00
10/100/1000	3000/4990/498	JICERB	150.00

The above multirange instruments are entirely self contained. The ranges are selected by a "positive detent" smooth working range switch which is similar in design to our large portable instruments.



***HIGH RESISTANCE DESIGN**

We suggest the use of the high resistance design wherever possible because of their higher torque to weight ratios.

•UNLESS SPECIFICALLY ORDERED, THE HIGH RESISTANCE TYPE WILL BE SUPPLIED.

Low resistance, high sensitivity instruments should be used only where a small amount of energy is available.

We suggest Diamond Pivots and shock mounted jewels on high sensitivity models where they have not already been included in the price. Add $30.00 to prices listed.

DIRECT CURRENT MILLIVOLTMETERS

MODEL J

Full Scale Millivolts	Resistance Ohms	Code Word	Price
1	5	JMVKAT	$117.00
2	10	JMVKEK	107.00
5	25	JMVKOS	105.00

Supplied and calibrated with 5 foot .026 ohm leads. If leads are not desired, deduct $5.00.

High Sensitivity DIRECT CURRENT GALVANOMETERS

MODEL J

Our Model J is particularly adaptable for use as a small, very sensitive, direct reading portable galvanometer. It is made in a variety of sensitivities, only a few of which are listed below. They are supplied either zero center or zero at left of scale.

Full Scale Microamps	Approximate Resistance	Microamps Per Division	Code	Price
‡* .5/0/.5	7200	.02	JALEE	$175.00
‡* 1/0/1	6200	.05	JALOS	145.00
2/0/2	5500	.1	JALER	123.00
5/0/5	3750	.2	JALIS	110.00
10/0/10	400	.5	JALUK	105.00
15/0/15	100	.5	JALAT	105.00
30/0/30	50	1	JALYI	105.00
50/0/50	10	2	JALLY	105.00

Special circuit closing push buttons, if desired. Add $15 to price.

The galvanometers listed below are recommended for circuits requiring VERY LOW resistance instruments.

‡ 7.5/0/7.5	150 ohms	JALBO	$125.00
‡ 15/0/15	50 ohms	JALCI	125.00
‡ 60/0/60	5 ohms	JALDU	125.00

* Accuracy on these high sensitivity ranges is 1%.
‡ Includes Diamond Pivots.

EDGEWISE PANEL HIGH SENSITIVITY DIRECT CURRENT INSTRUMENTS

In our opinion there is in engineering thinking, a definite trend away from inaccurate panel instruments. Granting the advantage of vertical mounting and the saving of valuable bench space, the accuracy limitations of the usual panel instrument leave much to be desired.

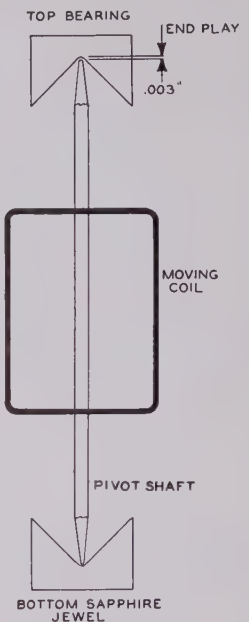
A panel instrument whose pivots are horizontal usually has an accuracy of 1%; or, if its accuracy is greater, its sensitivity is much lower. We have been asked many times "Why is it that such specifications appear to be the best available in vertical panel instruments?". The reason is as shown in the illustrations.

A bench type or portable precision instrument usually uses vertically disposed pivots. The entire weight of the moving coil is carried by the bottom pivot which is in constant contact with its sapphire jewel. A slight amount of end play in the top jewel will NOT materially change the position of the moving coil in the magnetic field. Such a design properly assembled will allow calibration accuracies to better than .05%. The very point of the pivot on the sapphire jewel will only be a few millionths of a square inch.

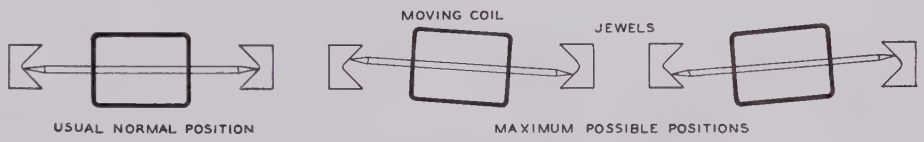
Now let us look at the usual panel instrument with horizontal pivots.

Note that we now have end play at both pivots and the moving coil can assume a variety of different positions in the magnetic field. Note also that the pivot bearing surfaces have more than DOUBLED over that of the vertical pivot design.

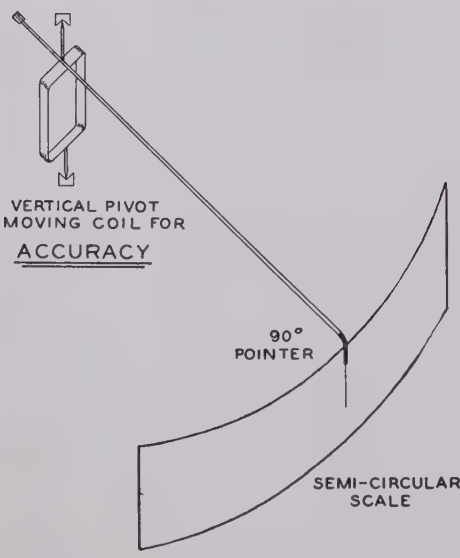
This very briefly explains why the accuracy of the usual panel instrument will not be better than 1%. It is due entirely to the uncertainty of position of the moving coil (called pivot slip or roll) as well as the added pivot friction on the jewels.



VERTICAL PIVOT



HORIZONTAL PIVOT — VERTICAL PANEL INSTRUMENT



BASIC ASSEMBLY EDGEWISE INSTRUMENT

MODEL DESIGNATIONS OF EDGEWISE PANEL INSTRUMENTS

Instruments that are available for edgewise panel mounting have their nomenclature based on the original portable models, as listed in this catalog, plus the suffix EW-5 or EW-7. The EW-5 designates an edgewise panel type with a 5" scale length, the EW-7 an edgewise panel type with a 7" scale length. In addition, there is both a shallow and deep EW-7 and EW-5 type. The furnishing of either a deep or shallow case is specific to the instrument model. In most cases, either the EW-5 or EW-7 is available for panel mounting any model, but there are some instances where because of high sensitivity, only the EW-5 case is offered.

As an example of the above nomenclature, if it was desired to panel mount the Model "C" in an EW-7 type case, the proper terminology for the instrument would be the Model CEW-7. The code word for the ranges of the Model "C" selected would remain the same. The Model "C" would have to be supplied in a shallow case. See page 215.

Where not specifically listed in a separate pricing schedule, there is an additional charge for edgewise panel mounting in an EW case.

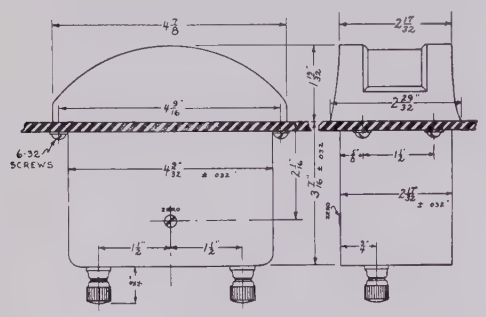
It is important to note that the Models "JW" and "JWSP" and their variations, are separate edgewise panel models by themselves and have no exact relationship to any other models listed in the catalog. The prices listed for them include the edgewise panel case.

We regret that the University Model and the Model N are not available for edgewise panel mounting.

MOUNTING DIMENSIONS

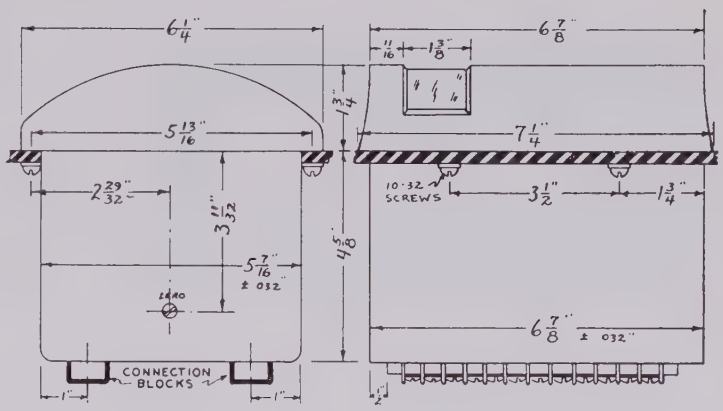
For "Sensitive Research" Edgewise Panel Cases

Practically all DC and Thermal instruments can be internally switch controlled for a maximum 8 ranges.



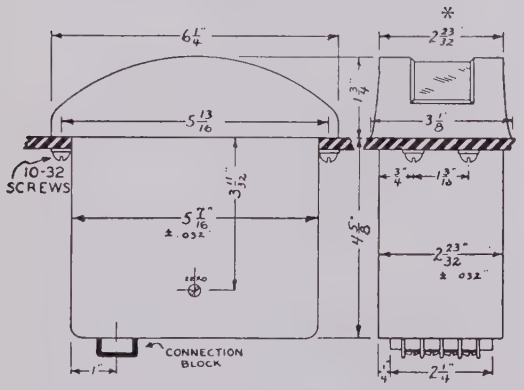
JW4 PANEL CASE

FOR MODELS JW, JDJW, JWG



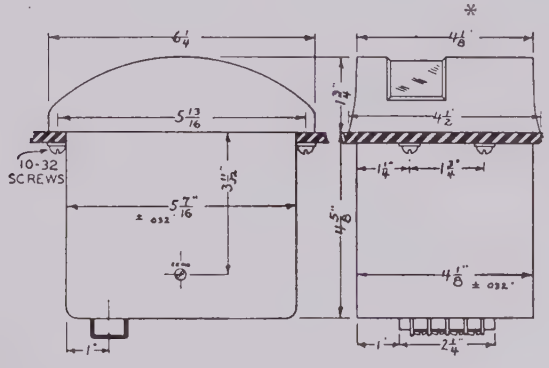
PDWEW "5" CASE

FOR MODEL PDW AND PDLW (3 phase wattmeters)



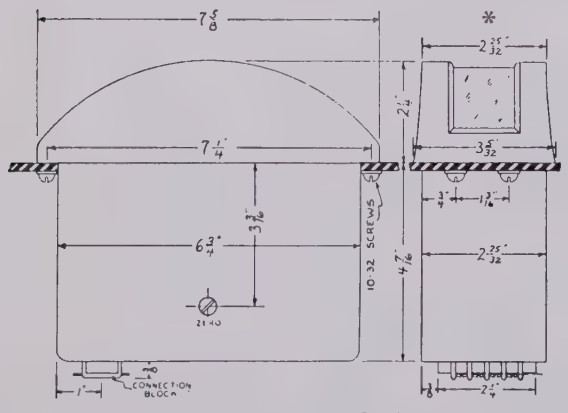
EW-5 SHALLOW CASE

FOR MODELS S, C, A, HS, MI, FS, FM, SD, RA, AU, XT, RF AND FLV



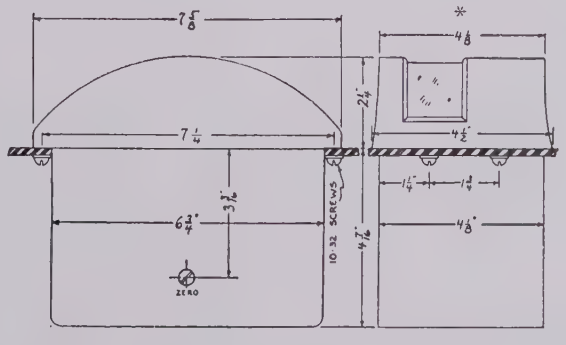
EW-5 DEEP CASE

FOR MODELS D, DLW, DW, ESD, GM, DYSP, FRE, PF AND PPF



EW-7 SHALLOW CASE

FOR MODELS S, C, FLV, MI, FS, FM, A AND RA



ESDEW-7 (DEEP CASE)

FOR MODELS DW, D, DYSP, ESD, FRE, PF AND PPF

No Dynamometer Wattmeters or Current instruments can be internally switch controlled.

NOTE: DUE TO SPACE LIMITATIONS, NO OVERLOAD SAFETY KEY IS AVAILABLE ON ABOVE EDGEWISE PANEL INSTRUMENTS.

*When instrument is supplied with an internal switch, this dimension increases by 9/16" to include the switch knob.

MODEL JW

Supplied with binding posts or terminal strip mounted on rear of case

This case design fulfills the need for a panel mounted instrument considerably more accurate than the usual panel mounted meter of 1% accuracy.

The movement has shock absorbing jewels with vertically disposed pivots. The full scale accuracy is .5 of 1%. It has a scale length of 4 inches and an anti-parallax mirror for better readability.

The case is of cast aluminum with a black wrinkle finish which will not chip or scratch.

SPECIFICATIONS

FOR PANEL MOUNTING

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	40 to 75
PERIOD	3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire Spring Mounted
SHIELDING	Magnetic & Electrostatic
CASE	Cast aluminum
SIZE	See page 215
INST. WEIGHT	3 pounds
SHIP. WEIGHT	7 pounds

IF DIAMOND PIVOTS ARE DESIRED ADD $30.00 TO LIST PRICE

DIRECT CURRENT MICROAMMETERS

SINGLE RANGE

Full Scale Microamperes	Approx. Resistance Ohms	Code Word	Price
*2	12000	JAWMIC	$145.00
*3	12000	JAWMIB	135.00
5	6400	JAWMIX	125.00
10	5500	JAWMIT	115.00
20	850	JAWMIS	110.00
50	100	JAWMIF	110.00
100	40	JAWMIO	110.00
200	10	JAWMIG	110.00

MULTIRANGE

Full Scale Microamperes	Approx. Resistance Ohms	Code Word	Price
*2.5/10	12000/375000	JAWMUE	$155.00
*3/6	5720/101000	JAWMOO	150.00
5/10	5720/78000	JAWMAA	140.00
10/20	2920/26500	JAWMII	130.00
5/20/100	6840/56600/14250	JAWMIQ	150.00
10/50/100	2500/13000/7300	JAWMIR	140.00
10/100/1000	2500/7260/787	JAWMIU	140.00
50/500/5000	189/315/35	JAWMIV	130.00
100/1000/10000	94/136/15	JAWMID	130.00

*Not magnetically shielded. Ranges under 5 microamperes have an accuracy of 1%.

DIRECT CURRENT MILLIAMMETERS

Full Scale Milliamperes	Approx. Resistance Ohms	Code Word	Price
1	50.0	JAWLIB	$105.00
3	10.0	JAWLIC	105.00
10	2.5	JAWLID	105.00
15	1.6	JAWLIF	105.00
30	2.0	JAWLIJ	105.00
75	1.2	JAWLIK	105.00
150	.7	JAWLIL	105.00
300	.3	JAWLIM	105.00

Full Scale Milliamperes	Approx. Resistance Ohms	Code Word	Price
.15/1.5/15	470/230/25	JAWLIN	$130.00
.5/2.5/5	150/150/95	JAWLIO	130.00
1.5/15/150	85/45/5	JAWLIP	130.00
3/7.5/15	16/30/15	JAWLIR	130.00
15/75/150	3.5/3/2	JAWLIS	130.00
30/75/300	3/3/1	JAWLIT	130.00
50/250/500	.9/.4/.2	JAWLIW	130.00
75/150/300	1.1/.7/.3	JAWLIX	130.00

DIRECT CURRENT MILLIVOLTMETERS

Full Scale Millivolts	Resistance Ohms	Code Word	Price
1.5	7.5	JAWVOL	$130.00
2	10	JAWVOM	125.00
5	25	JAWVOS	122.00
10	50	JAWVOT	120.00
†50	250	JAWVOU	120.00

†Suggested for use with external shunts. Scale markings in "AMPERES," if desired.

Internal switching not available in the Model JW due to space limitations.

Full Scale Millivolts	Resistance Ohms	Code Word	Price
1.5/6	7.5/30	JAWVOB	$145.00
2/5	10/25	JAWVOC	140.00
2/5/10	10/25/50	JAWVOG	150.00
2/10/20	10/50/100	JAWVOX	150.00

Millivoltmeters supplied and calibrated with 5' .026 ohm leads. If leads are not desired, deduct $5.00.

MODEL JWG
GALVANOMETERS

This galvanometer is a very sensitive double pivoted moving coil instrument which is calibrated in MICROAMPERES. Knowing the microampere value of each division saves time and reduces calculations.

The moving coil system responds quickly to small changes in current because it has a relatively short period. The Model JWG is valuable for:

1st Measuring small DC currents. It has high sensitivity over a long scale.

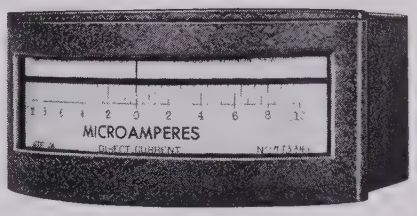
2nd Wheatstone bridge measurement when used as a null indicator.

3rd The measurement of small differences of potential. The instrument resistance is very low and will put a minimum load on the circuit. Recommended for thermocouple work with low resistance potentiometers.

	Full Scale Microamperes	Internal Resist. Ohms	Code Word	Price
1.	15 - 0 - 15	150	JAWGAL	$133.00
2.	25 - 0 - 25	50	JAWGAK	130.00
3.	100 - 0 - 100	5	JAWGAM	130.00

Binding posts are located in back of case

These Galvanometers have diamond pivots and spring mounted jewels.



MODEL JWG GALVANOMETERS
Accuracy .5 of 1%
Scale Length 4"

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	50 to 75
PERIOD	3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Cast Aluminum
SIZE	See page 215
INST. WEIGHT	3 pounds
SHIP. WEIGHT	8 pounds

IF DIAMOND PIVOTS ARE DESIRED ON VOLTMETERS ADD $30.00 TO LIST PRICE

DIRECT CURRENT VOLTMETERS

MODEL JW

The Model JW is ideal for consideration by OEM users because it combines accuracy, sensitivity and ruggedness in a relatively low priced instrument. It takes only a small amount of panel space yet has a long 4" scale.

SINGLE RANGE

Full Scale Volts	Code Word	1000 Ohms per V	5000 Ohms per V	Code Word
1	JAWVOLT	$105.00	$115.00	JAWVOLTX
3	JAWVOMK	105.00	115.00	JAWVOMKX
7.5	JAWVOSO	105.00	115.00	JAWVOSOX
15	JAWVOTI	105.00	115.00	JAWVOTIX
50	JAWVOKY	105.00	115.00	JAWVOKYX
150	JAWVOTT	115.00	125.00	JAWVOTTX
300	JAWVORL	120.00	130.00	JAWVORLX
500	JAWVOIM	125.00	135.00	JAWVOIMX

MULTIRANGE

1.5/7.5/15	JAWVOPO	$125.00	$139.00	JAWVOPOX
1.5/15/150	JAWVOSK	135.00	149.00	JAWVOSKX
2/20/200	JAWVOJA	137.00	152.00	JAWVOJAX
3/15/75	JAWVOOL	135.00	149.00	JAWVOOLX
7.5/30/150	JAWVOXO	135.00	149.00	JAWVOXOX
15/75/150	JAWVOBU	135.00	149.00	JAWVOBUX
15/150/300	JAWVOCA	140.00	155.00	JAWVOCAX
30/75/150	JAWVODI	140.00	155.00	JAWVODIX
75/150/300	JAWVOFE	140.00	155.00	JAWVOFEX

Equipped with BINDING POSTS or TERMINAL STRIP, located in back of case.

UNIVERSITY MODEL

MAGNETICALLY SHIELDED

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 to 100
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Moulded Bakelite
SIZE	5 9/16" x 5 3/8" x 3"
INST. WEIGHT	3¾ pounds
SHIP. WEIGHT	8 pounds

IF DIAMOND PIVOTS ARE REQUIRED
ADD $30.00 TO LIST PRICE

The UNIVERSITY MODEL is made in a complete line of D.C. microammeters, milliammeters, voltmeters and millivoltmeters. They are particularly adapted for industrial and educational requirements where a rugged, reliable, portable instrument of **CONSISTENT** high accuracy is required.

They require no exact leveling. Wide variations in temperature do not affect their initial accuracy. The scales are all drawn by hand-controlled mechanical scale machines, producing scales that are distinctly in a precision class by themselves. ALL "SENSITIVE RESEARCH" instruments are fitted with white enameled brass scales. Paper scales are today considered obsolete, as they warp and shred with changing atmospheric conditions.

The case is of polished bakelite. It is structurally strong and a good dust and moisture barrier. A range switch, when included, is moulded integral with the panel. The case has a substantial black leather carrying strap, and its fittings are of bright chrome plated brass.

SINGLE RANGE

HIGH Resistance Design

Full Scale Microamperes	HIGH Approx. Resist.	Code	Price
‡† 2	12000	UXNICIK	$140.00
‡† 3	12000	UXNICCO	130.00
5	12000	UXNICAB	122.00
10	12000	UXNICED	122.00
15	7000	UXNICIC	120.00
20	6400	UXNICOF	118.00
25	3000	UXNICUG	112.00
30	3000	UXNICAJ	112.00
50	1200	UXNICEK	112.00
100	1200	UXNICIL	107.00
200	440	UXNICOM	107.00
300	300	UXNICUM	107.00
500	100	UXNICAP	107.00

•LOW Resistance Design

Full Scale Microamperes	LOW Approx. Resist.	Code	Price
5	6400	UNICAB	$130.00
10	5500	UNICED	127.00
15	3750	UNICIC	127.00
20	850	UNICOF	127.00
25	200	UNICUG	121.00
30	100	UNICAJ	121.00
50	100	UNICEK	121.00
100	40	UNICIL	121.00
200	10	UNICOM	121.00
300	10	UNICUM	121.00
500	10	UNICAP	121.00

•UNLESS SPECIFICALLY ORDERED, THE HIGH RESISTANCE DESIGN WILL BE SUPPLIED

•Recommended for use in circuits where a low resistance instrument must be used to eliminate unbalance or change in existing circuit conditions. For other low resistance microammeters, please see the Model J, pages 212 and 213, or the Model S, pages 203 and 204.

†NOT magnetically shielded.

‡Accuracy 1%.

UNIVERSITY MODEL

HORIZONTAL *USE ONLY*

MAGNETICALLY SHIELDED

TRIPLE RANGE

HIGH Resistance Design

Full Scale Microamperes	HIGH Res. Ohms	Code Word	Price
5/20/100	6840/56600/14250	UXNICTO	$147.00
10/50/100	11550/48500/27000	UXNICBA	142.00
10/100/1000	11550/27000/2970	UXNICDI	142.00
15/30/150	11500/78000/27000	UXNICKO	142.00
20/100/200	2875/11300/6325	UXNICIK	137.00
20/200/2000	2875/6325/692	UXNICOJ	137.00
30/150/750	2560/8100/1920	UXNICKA	135.00
30/300/3000	2560/4525/495	UXNICLO	135.00
100/1000/10000	700/500/55	UXNICMU	129.00
150/1500/15000	272/272/30	UXNICPY	129.00
200/2000/20000	143/46/5	UXNICRA	129.00

LOW Resistance Design

LOW Res. Ohms	Code Word	Price
5930/13000/7300	UNICBA	$157.00
5930/7260/787	UNICDI	157.00
5920/21500/7250	UNICKO	157.00
1042/3240/1810	UNICIK	151.00
1042/1810/198	UNICOJ	151.00
794/1950/462	UNICKA	149.00
794/1090/118	UNICLO	149.00
94/136/15	UNICMU	143.00
46/54/6	UNICPY	143.00
18/27/3	UNICRA	143.00

All the above instruments have range selector switches.

MULTIRANGE, WITH RANGE CHANGING SWITCH

We recommend the use of the **HIGH** resistance design wherever possible. They have a higher torque, are less expensive and more rugged than the **LOW** resistance design.

MULTIRANGE

We, through experience, suggest the use of a multirange instrument. When considering the price of a single range instrument, it may be worth remembering that for a slight additional charge, one or more extra ranges may be obtained. This creates a more flexible instrument which helps to reduce future laboratory costs. Good instrumentation and convenience as well as economy dictate their use.

Since the exact current at the beginning of a test is seldom known, it is advantageous to use a multirange instrument. By starting at the highest current range and progressively switching down to the correct range, the danger of overloading the instrument is markedly reduced.

Diamond Pivoted instruments can be supplied at an additional cost of $30.00.

HIGH Resistance Design

Full Scale Microamperes	HIGH Res. Ohms	Code Word	Price
5/50/500/5000	6942/27050/2971/300	UXNICNO	$160.00
10/30/100/300/1000	11550/68000/27000/9700/2970	UXNICII	162.00
10/50/100/500/1000	11550/48500/27000/5880/2970	UXNICAA	162.00
10/100/1000/10000	11550/27000/2970/300	UXNICEE	155.00
20/200/2000/20000	2875/6325/692/69	UXNICOO	149.00
30/150/300/1500/3000	2560/7600/4525/998/495	UXNICOU	152.00
30/300/3000/30000	2560/4525/495/49	UXNICOY	149.00
50/500/5000/50000	1145/2260/247/24	UXNICIO	141.00
100/500/1000/5000/10000	745/1160/547/117/59	UXNICUK	145.00

LOW Resistance Design

LOW Res. Ohms	Code Word	Price
5920/18400/6900/2750/792	UNICII	$177.00
5920/13000/7300/1570/792	UNICAA	177.00
5920/7260/787/79	UNICEE	170.00
1042/1810/198/20	UNICOO	164.00
794/1950/1090/235/118	UNICOU	168.00
794/1090/118/12	UNICOY	164.00
189/315/35/3.4	UNICIO	156.00
94/243/136/29/15	UNICUK	160.00

All the above instruments have range selector switches.

UNIVERSITY MODEL

Dependability is probably the most important characteristic that a maker of electrical instruments strives to build into his product. We believe we have attained this goal. Correct proportioning of the movement results in a very small moment of inertia, causing the pointer to follow faithfully slight or rapid changes in the circuit under measurement. This, together with a well aged magnet, produces a dependable instrument.

These portables all have knife edged pointers and mirrored scales to eliminate parallax reading errors.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 to 100
PERIOD	2 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Moulded Bakelite
SIZE	$5\frac{9}{16}$" x $5\frac{3}{8}$" x 3"
INST. WEIGHT	$3\frac{3}{4}$ pounds
SHIP. WEIGHT	8 pounds

IF DIAMOND PIVOTS ARE REQUIRED ADD $30.00 TO LIST PRICE

SINGLE RANGE

Full Scale Milliamperes	Approx. Res. Ohms	Code Word	Price
1.	50.0	UNILEC	$98.00
1.5	50.0	UNILID	98.00
3.	10.0	UNILOE	98.00
5.	3.0	UNILOG	98.00
10.	2.5	UNILEJ	98.00
15.	1.6	UNILIK	98.00
20.	5.0	UNILOL	98.00
25.	4.5	UNILUM	98.00
30.	2.0	UNILAN	98.00
50.	1.7	UNILEO	98.00
75.	1.2	UNILIP	98.00
100.	.8	UNILOR	98.00
150.	.7	UNILUS	98.00
200.	.5	UNILAT	98.00
250.	.4	UNILEV	98.00
300.	.3	UNILIW	98.00
500.	.2	UNILOX	98.00
1000.	.1	UNILUY	98.00

•TRIPLE RANGE

Full Scale Milliamperes	Approx. Res. Ohms	Code Word	Price
.15/1.5/15	470/230/25	UNILMA	$129.00
.5/2.5/5	150/150/95	UNILMO	123.00
1.5/15/150	85/45/5	UNILME	123.00
3/7.5/15	16/30/15	UNILMI	123.00
7.5/15/30	5/14/10	UNILMY	123.00
15/75/150	3.5/3/2	UNILMU	123.00
30/75/300	3/3/1	UNILMF	123.00
50/250/500	.9/.4/.2	UNILMK	123.00
75/150/300	1.1/.7/.3	UNILML	123.00
150/300/750	.5/.3/.1	UNILMM	123.00
250/500/1000	.4/.2/.1	UNILMP	123.00

•MULTIRANGE MILLIAMMETERS

HIGH Resistance Design

Full Scale Milliamperes	Approx. Resistance Ohms	Code Word	Price
.01/.1/1/10/100	11500/27000/2970/300/30	UXNILLO	$163.00
†.01/.05/.1/.5/1/5/10/50	11550/68000/27000/6000/ 3000/599/299/100	UXNILSU	185.00
.02/.2/2/20/200	2875/6325/692/69/7	UXNILBA	157.00
.03/.3/3/30/300	2560/4525/495/49/5	UXNILDI	155.00
.05/.5/5/50/500	1145/2260/247/24/2.4	UXNILJO	153.00
.1/1/10/100/1000	745/547/59/6/.6	UXNILKI	153.00
†.1/.5/1/5/10/50/100	745/1100/547/110/59/12/6	UXNILFY	175.00
.15/1.5/15/150/1500	268/228/25/2.4/.25	UXNILPY	153.00
.2/2/20/200	183/137/14.8/1.5	UXNILRO	145.00
.5/5/50/500	100/91/9.9/1	UXNILEE	145.00

LOW Resistance Design

Approx. Resistance Ohms	Code Word	Price
5930/7260/787/79/8	UNILLO	$178.00
5930/18400/6900/2590/ 792/265/80/26	UNILSU	200.00
1042/1810/198/20/2	UNILBA	172.00
794/1090/118/12/1.2	UNILDI	170.00
189/315/35/3.4/.35	UNILJO	168.00
47/73/8/.8/.08	UNILKI	168.00
47/140/73/16/8/1.6/.8	UNILFY	190.00
49/55/6/.6/.06	UNILPY	168.00
23/32/3.5/.35	UNILRO	160.00
9.2/9.9/.9/.1	UNILEE	160.00

• These instruments all have range selector switches.

† Only 6 ranges on selector switch (added ranges will be supplied with Binding Posts, short position omitted).

We recommend the use of the HIGH resistance design wherever possible. They have a higher torque, are less expensive and are more rugged than the LOW resistance design. Low torque instruments should only be used where high resistance instruments would unbalance or change existing circuit conditions.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 to 100
PERIOD	1 second
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Moulded Bakelite
SIZE	5 9/16" x 5 3/8" x 3"
INST. WEIGHT	3¾ pounds
SHIP. WEIGHT	8 pounds

IF DIAMOND PIVOTS ARE REQUIRED ADD $30.00 TO LIST PRICE

UNIVERSITY MODEL

These "University Model" direct current Ammeters, Voltmeters and Millivoltmeters are fast reading instruments. The damping, accomplished by eddy currents set up in the moving coil frame, is nearly aperiodic so that the pointer comes almost immediately to rest at zero or any deflected position. This saves time in taking readings.

These instruments are so designed that they may be left in their circuit continuously. They can be used over a wide range of temperature without causing errors that will exceed their guaranteed accuracy of .5 of 1%. Their range changing switch is moulded integral with the panel itself. Individual tests by separate laboratories have proven that this switch will operate without deterioration after many years of rigorous service.

The University model is a very popular, moderately priced laboratory instrument.

DIRECT CURRENT AMMETERS

SINGLE RANGE ONLY

Full Scale Amperes	Code	Price
1	UNAMAB	$98.00
2	UNAMID	98.00
5	UNAMOF	98.00
10	UNAMPO	100.00

DIRECT CURRENT VOLTMETERS

Any SINGLE RANGE Voltmeter, from 1.5 to 1000 volts, Price and specifications same as model UPP, see page 227.

MULTIRANGE

Volts	Code	1000 Ohms Per Volt	Code	5000 Ohms Per Volt
1.5/7.5/15	UNVOOL	$128.00	UNVOOLS	138.00
1.5/15/150	UNVOIP	128.00	UNVOIPS	138.00
3/15/75	UNVOAK	128.00	UNVOAKS	138.00
7.5/30/150	UNVOUT	128.00	UNVOUTS	138.00
15/75/150	UNVOSY	128.00	UNVOSYS	138.00
15/150/300	UNVORY	137.00	UNVORYS	147.00
30/75/150	UNVOIT	128.00	UNVOITS	138.00
75/150/300	UNVOVI	137.00	UNVOVIS	147.00
75/300/750	UNVOWO	145.00	UNVOWOS	155.00
150/300/750	UNVOXY	145.00	UNVOXYS	155.00
1.5/3/7.5/15/30	UNVOYO	153.00	UNVOYOS	163.00
3/15/75/150/300	UNVOZI	160.00	UNVOZIS	170.00
5/20/50/200/500	UNVOLL	163.00	UNVOLLS	173.00
15/30/75/150/300/750	UNVOSS	175.00	UNVOSSS	185.00

DIRECT CURRENT MILLIVOLTMETERS

SINGLE RANGE

Millivolts	Approx. Res.	Code	Price
2	10 ohms	UNMVAB	$118.00
5	25 ohms	UNMVIT	115.00
10	50 ohms	UNMVBI	113.00
50	250 ohms	UNMVLO	113.00
100	500 ohms	UNMVNA	113.00

MULTIRANGE

Millivolts		Code	Price
*2/5/10/20	5 ohms per millivolt	UNMVSY	$148.00
*2/5/20/50		UNMVSO	148.00
*2/10/50/100		UNMVTA	148.00
10/20/50/100		UNMVVE	143.00
10/50/100/200		UNMVYU	143.00

*2 m.v. range only on Binding Posts.

All millivoltmeters are supplied with 5 feet .026 ohm leads. Their potential drop is taken at the end of these leads. If leads are NOT required deduct $5.00, and specify that calibration is to be made at the terminals.

SCALE will be calibrated in millivolts DC unless otherwise specified.

The legend "Amperes Direct Current" can be supplied at no extra charge. Either 100 or 75 divisions can be printed. For a dual scale add $15.00.

See Shunt section for specifications.

MODEL UPP — 4" Scale — See page 223
MODEL NP — 6.1" Scale — See page 231

NEW VERTICALLY MOUNTED DIRECT CURRENT PANEL INSTRUMENTS

WITH AN ACCURACY OF

.5 OF 1 PERCENT!

AND — MECHANICALLY CAPABLE OF WITHSTANDING ELECTRICAL OVERLOADS OF 10,000 PERCENT

MODEL UPP
FLUSH MOUNTED
COMPLETELY SWITCH CONTROLLED
4" SCALE LENGTH

AMMETERS

VOLTMETERS

MILLIAMMETERS

MICROAMMETERS

MILLIVOLTMETERS

STANDARD FEATURES ON THESE MOST MODERN AND ADVANCED DESIGN PANEL INSTRUMENTS ARE

1. *Individually calibrated hand drawn scale.*
2. *Anti-parallax mirror.*
3. *Magnetic Shielding.*
4. *Electrostatic Shielding.*
5. *Temperature compensation.*
6. *Warp-proof scale plate.*
7. *Knife edge pointer.*
8. *Self contained. (Unless otherwise noted.)*
9. *Internal adjustable Magnetic Shunt.*
10. *Large, stable moving coil assemblies. (All Sensitive Research Instrument Corporation panel instruments contain the same moving coil and permanent magnet assemblies that exist in our .1 of 1% accurate Laboratory Standards. No concession is made in size or quality of components. This differs greatly from the design of the usual panel instrument with its small coil and permanent magnet, where low cost production is of first importance and dictates component quality.)*

A NEW VERTICALLY MOUNTED PANEL INSTRUMENT

RECTANGULAR PANEL D.C. INSTRUMENTS

Accuracy .5 of 1% Scale length 4 inches

FLUSH MOUNTING
COMPLETELY
SWITCH CONTROLLED

The Model UPP has been designed to hold up under severe electrical overloads. Its rugged movement can be made to mechanically withstand electrical overloads of **10,000%** of the instruments full scale value. Because of this characteristic, the Model UPP is ideally suited for applications such as vacuum tube testing, etc., where a substantial overload may inadvertently be applied.

IMPORTANT

The model UPP is available with special scales to fit your application. Correspondence suggested. The model UP and UPP have identical dimensions.

Model UPP

SENSITIVE RESEARCH has, for many years, noted a growing need for highly accurate, fast acting, rugged vertical panel mounted instruments. It is with great pride that we announce the completion of a long research projejct that has resulted in the development of an exceptional .5 of 1% vertical panel mounted instrument.

Our new Model UPP has an exceptionally high torque-weight ratio, and consequently, a split second period. Its large Alnico V magnet, lightweight movement, well proportioned high carbon steel pivots, and natural sapphire jewels combine to create an instrument that will withstand severe handling and resistance to shock and vibration.

The ordinary vertical panel instrument exhibits pivot roll in varying degrees, the Model UPP has none. The scale is hand drawn and each instrument is individually calibrated. Damping is almost critical, allowing for instantaneous readings. The Model UPP is truly an innovation in the field of vertical panel instruments.

The Model UPP cannot be made as sensitive as our edgewise panel instruments. However, sensitivities are available from 200 microamperes and higher in D.C. current. Current instruments are higher in resistance than the edgewise panel types. The basic volt range available is from 1.5 volts at 1000 ohms/volt, and 7.5 volts at 5000 ohms/volt. A special 0 - 50 and 0 - 100 millivoltmeter is listed for heavy current shunt use.

Correspondence on your particular requirements and applications is invited. If the instruments are to be mounted in steel panels please advise the thickness of the panel and the proximity of other permanent magnet instruments. Although the Model UPP is well shielded, as a special service, calibration can be made duplicating your exact operating conditions.

MODEL UPP

MAGNETICALLY SHIELDED

MICROAMMETERS

Full Scale Values	Approx. Res. Ohms	Code Word	Price
200	6000	UPPICOP	$105.00
300	3000	UPPICUB	105.00
500	800	UPPICAP	105.00
750	250	UPPICET	105.00

FACSIMILE 100 DIVISION - 4" LONG SCALE

We regret that the Models UPP and UP are not available with Diamond Pivots.

PROJECTION MOUNTING

SPECIFICATIONS

FOR PANEL MOUNTING

ACCURACY	1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 to 100
PERIOD	2 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Moulded Bakelite
SIZE	$5\frac{9}{16}$" x $5\frac{3}{8}$" x 3"
INST. WEIGHT	3¾ pounds
SHIP. WEIGHT	8 pounds

MODEL UP

FOR PANEL MOUNTING

The trend in modern instrument design is toward multirange, more versatile types.

While it is possible that only a single range may be needed immediately, future requirements may necessitate measurements over a wider area. The purchase of a multirange instrument with an internal selector switch, therefore, has very practical economic considerations. In addition, since an instrument's accuracy is rated in per cent of full scale, overlapping ranges also provide greater accuracy in terms of reading. A multirange instrument costs only a few dollars more than a single and is invaluable when needed.

The moving element of this Model UP is identical in design, except for size, to that of our well known Model S precision instrument. This design has been time tried and proved by 33 years of service in all types of D'Arsonval instruments.

The high torque of the moving coil makes it possible for its pointer to faithfully follow small and rapid changes in the circuit under measurement. The scale is fitted with an anti-parallax mirror.

This Model UP is made in a complete line of DC microammeters. It is supplied either for flush or projection mounting. See page 227 for mounting dimensions. Flush mounted instruments are supplied unless the projection type is ordered.

The range selector switch has very positive click positioning and operates smoothly. After artificially experiencing years of operation in our test laboratory, this switch showed practically no wear or material change in contact resistance.

MULTIRANGE

Full Scale Microamperes	Approx. Resistance Ohms	Code Word	Price
50/100/250	10950/34000/20400	UPICED	$124.00
50/250/500	10950/20400/10200	UPICUR	124.00
50/250/1000	10950/20400/5950	UPICOT	124.00
100/500/1000	5730/9000/5000	UPICOK	119.00
50/250/500/1000/2500	10200/19600/10900/5640/2360	UPICOW	142.00
75/150/300/750/1500	5820/17700/12600/5900/3100	UPICUT	140.00
75/300/750/1500/3000	5820/12600/5900/3100/1585	UPICYL	140.00
100/250/500/1000/2500	5730/14100/9000/4560/2160	UPICAR	137.00
150/300/750/1500/3000	5780/11900/11900/5460/2860	UPICEX	137.00
100/500/1000/2500/5000	5730/9000/4560/2160/1080	UPICIK	137.00

SINGLE RANGE

Full Scale Microamperes	Approx. Res.	Code Word	Price
30	12000 ohms	UPICOX	$110.00
50	12000 ohms	UPICUS	110.00
100	6400 ohms	UPICEM	105.00

We regret that the models UP and UPP are not available with Diamond Pivots.

These instruments are magnetically shielded for use on steel panels. Please advise THICKNESS of your steel panel when placing order. If more than one instrument is mounted on panel, state the proximity to other instruments being mounted. As a special service we can calibrate the instruments duplicating your operating conditions.

See page 227 for mounting dimensions.

SPECIFICATIONS

FOR PANEL MOUNTING

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 to 100
PERIOD	2 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Moulded Bakelite
SIZE	$5\frac{9}{16}$" x $5\frac{3}{8}$" x 3"
INST. WEIGHT	$3\frac{3}{4}$ pounds
SHIP. WEIGHT	8 pounds

MODEL UPP

D.C. MILLIAMMETERS

Models UPP and UP are not available with Diamond Pivots

SINGLE RANGE

Full Scale Milliamperes	Approximate Resistance Ohms	Code Word	Price
1.0	175	UPPILEC	$98.00
2	38	UPPILID	98.00
5	18	UPPILOE	98.00
10	4	UPPILUF	98.00
15	3	UPPILAG	98.00
20	2	UPPILEJ	98.00
25	1.5	UPPILIK	98.00
30	1.2	UPPILOL	98.00
50	7	UPPILUM	98.00
100	6	UPPILAP	98.00
150	3	UPPILER	98.00
200	2	UPPILIS	98.00
300	1.4	UPPILUV	98.00
500	1.2	UPPILAW	98.00
750	1	UPPILEX	98.00

MULTIRANGE

Full Scale Milliamperes	Approx. Res. Ohms	Code Word	Price
1/5/10	140/260/145	UPPMILBS	$123.00
1.5/3/15	43/135/45	UPPMILCT	123.00
3/7.5/15	33/79/50	UPPMILGS	123.00
3/15/30	33/49/27	UPPMILHT	123.00
7.5/15/30	22/30/22	UPPMILJE	123.00
7.5/30/75	22/10/6	UPPMILKO	123.00
10/50/100	15/15/9.2	UPPMILLE	123.00
15/30/75	8.3/14/8.3	UPPMILND	123.00
15/75/150	8.3/8.3/4.6	UPPMILOS	123.00
30/75/150	4.2/6.6/4.2	UPPMILRO	123.00
30/150/300	4.2/4.2/2.4	UPPMILSI	123.00
50/250/500	3.8/2.3/1.4	UPPMILTY	$123.00
75/150/300	3.3/3.3/2.1	UPPMILUZ	123.00
100/250/500	3/1.8/1	UPPMILVE	123.00
250/500/1000	1.9/1.5/.75	UPPMILWS	123.00
1.5/3/15/75/150	43/135/45/10/5	UPPMILOK	138.00
3/7.5/30/150/300	33/79/27.5/5.9/2.9	UPPMILET	138.00
5/25/100/250/500	14/16/4/1.6/1	UPPMILAS	138.00
15/75/150/300/750	8.3/8.3/4.6/2.5/1	UPPMILKY	138.00
30/75/150/300/750	4.2/6.6/4.2/2.4/1	UPPMILNI	138.00
30/75/300/750/1500	4.2/6.6/2.4/1/.5	UPPMILUT	138.00

All the above instruments are supplied with selector switches. A terminal strip for multirange instruments instead of the switch, is available at the same cost.

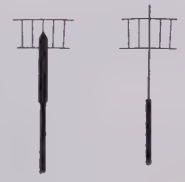
PROJECTION MOUNTING

D.C. AMMETERS

Full Scale Amperes	Approx. Res. Ohms	Code Word	Price
1.0	.15	UPPAMAB	$98.00
2.0	.075	UPPAMEK	98.00
3.0	.05	UPPAMID	98.00
5.0	.03	UPPAMEF	98.00
7.5	.02	UPPAMOF	98.00
10	.015	UPPAMER	100.00
15	.005	UPPAMIG	102.00
20	.004	UPPAMUL	105.00
30	.002	UPPAMGI	115.00
50	.0015	UPPAMHU	125.00

FLUSH OR PROJECTION MOUNTINGS AT THE SAME PRICE

See page 227 for mounting dimensions.



LANCE KNIFE

All instruments are provided with knife edge pointers unless a lance type is specified.

FLUSH MOUNTING INSTRUMENTS WILL BE SUPPLIED UNLESS PROJECTION INSTRUMENTS ARE SPECIFICALLY ORDERED

SPECIFICATIONS

FOR PANEL MOUNTING

ACCURACY	.5 of 1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 to 100
PERIOD	2 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic

MODEL UPP

DIRECT CURRENT VOLTMETERS

Models UPP and UP are not available with Diamond Pivots

These voltmeters are identical in design and outside appearance to previously described Model UPP instruments. They are supplied either as "flush" or "projection" mounted instruments. The instrument's dignified appearance matches its built-in precision and its graceful simplicity is an asset to any panel in which it may be mounted. It is completely switch controlled and has an anti-parallax mirror scale. Flush mounting is supplied unless otherwise requested.

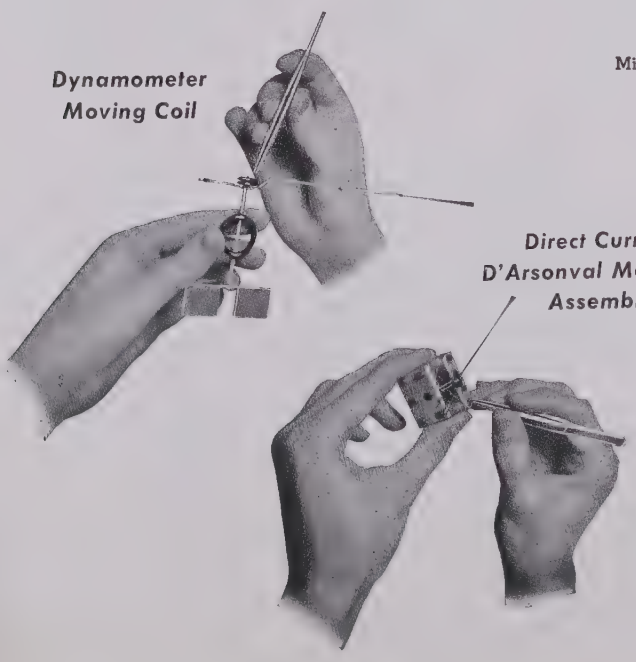
As voltmeters, they are supplied having a sensitivity of 1000 or 5000 ohms per volt. All instruments are switch controlled up to 1000 volts.

Full Scale Volts	Code	PRICE 1000 Ohms Per Volt	PRICE **5000 Ohms Per Volt
1.5	UPPOLYO	$ 98.00	—
3	UPPOLAR	98.00	—
7.5	UPPOLET	98.00	$108.00
15	UPPOLLA	98.00	108.00
50	UPPOLLY	98.00	108.00
150	UPPOLIK	98.00	108.00
300	UPPOLUT	98.00	108.00
500	UPPOLSK	100.00	110.00
750	UPPOLTO	104.00	114.00
1000	UPPOLVY	108.00	118.00
1.5/7.5/15	UPPOLSI	128.00	—
3/15/30	UPPOLDI	128.00	—
5/50/100	UPPOLZY	128.00	—
7.5/30/75	UPPOLFU	128.00	138.00
10/50/200	UPPOLGY	130.00	140.00
10/100/500	UPPOLHA	140.00	150.00

Full Scale Volts	Code	PRICE 1000 Ohms Per Volt	PRICE **5000 Ohms Per Volt
15/30/75	UPPOLIZ	$128.00	$138.00
15/75/150	UPPOLJO	128.00	138.00
30/75/150	UPPOLMA	128.00	138.00
30/150/300	UPPOLNI	137.00	147.00
75/150/300	UPPOLOT	137.00	147.00
150/300/750	UPPOLPY	145.00	155.00
200/500/1000	UPPOLRA	150.00	160.00
3/7.5/30/150/300	UPPOLTU	160.00	—
10/20/100/200/500	UPPOLII	163.00	173.00
15/75/150/300/750	UPPOLVO	168.00	178.00
30/75/150/300/750	UPPOLWA	168.00	178.00
*50/100/200/500/1000	UPPOLYN	173.00	183.00

*Supplied with part of its multiplier in a small cage attached to the rear of the case.

**When ordering 5000 ohms per volt instruments add "S" to the appropriate code word.



MILLIVOLTMETERS

Millivolts	Approx. Resistance Ohms	Code	Price
50	12	UPPMVKA	$110.00
100	24	UPPMVSI	110.00
50/100	12/24	UPPMVTU	135.00

Suggested for use with external current shunts 5' calibrated leads .026 ohm, are furnished.

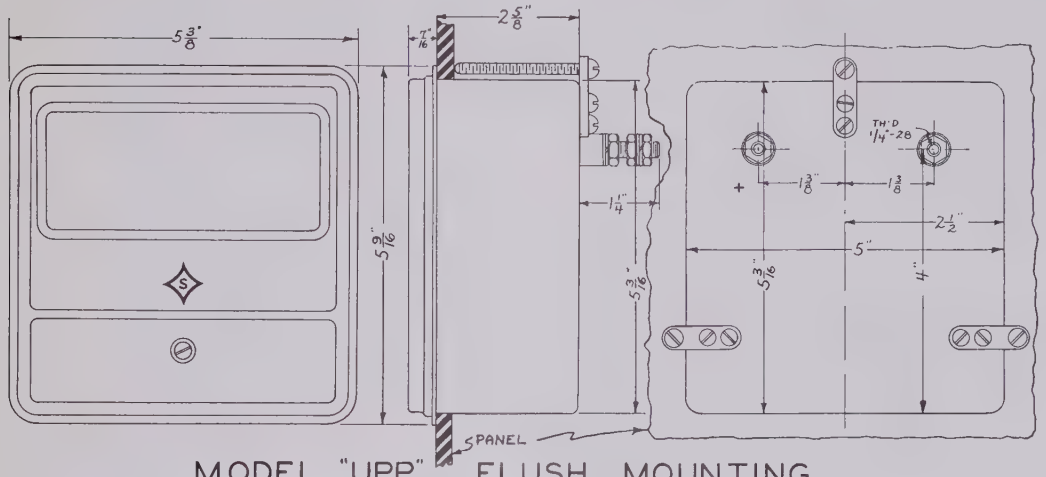
"The Hands of Our Crafts People Are Our Most Precise Equipment"

"MOUNTING AND DIMENSIONS" of the RECTANGULAR PANEL INSTRUMENTS

MODELS UP, UPP & NP

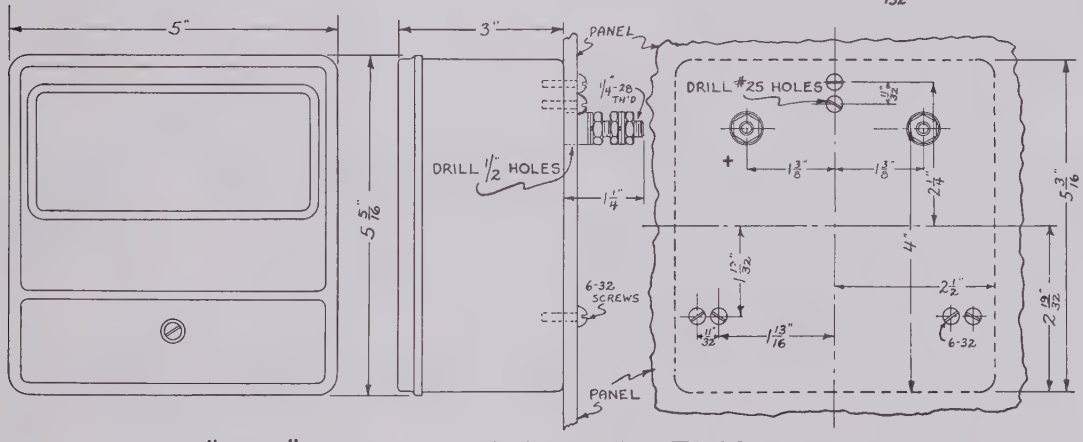
FLUSH AND PROJECTION MOUNTING

*FURNISHED WITH STUDS OR BINDING POSTS

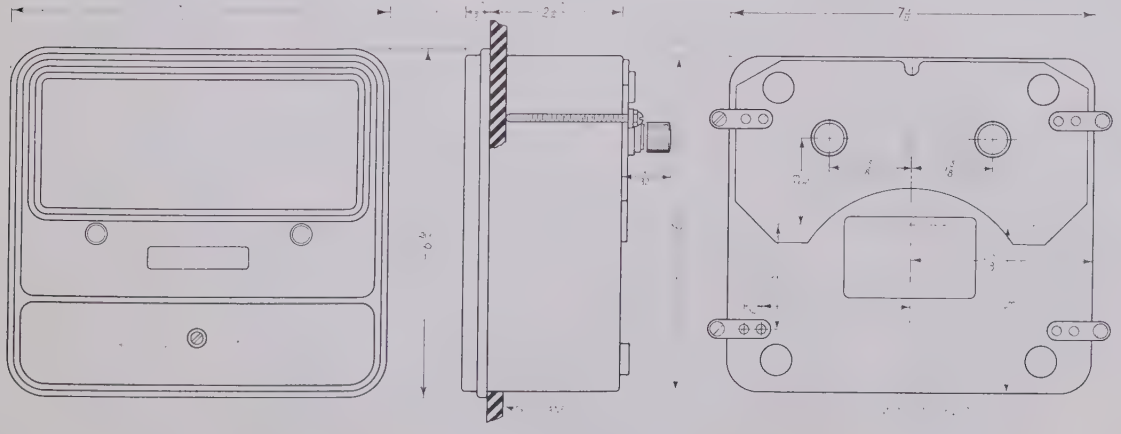


MODEL "UPP" FLUSH MOUNTING

ALL DIMENSIONS ± 1/32 INCH



"UPP" PROJECTION MOUNTING



MODEL "NP" FLUSH MOUNTING

*Multirange instruments are normally furnished internally switch controlled. If a terminal strip with each range brought out separately is desired instead of a switch, it is available at no extra charge but must be specified.

DIRECT CURRENT KILOVOLTMETER

MODEL DCHI

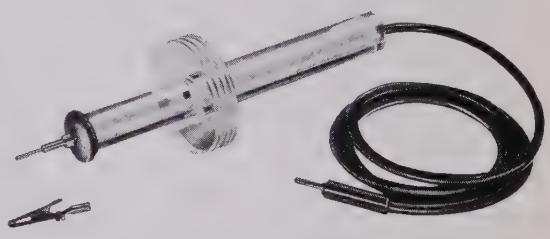
SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	1%
SCALE LENGTH	4 inches
SCALE DIVISIONS	60 and 75
PERIOD	2 - 3 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Formica
SIZE	13¾" x 7½" x 8¼"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

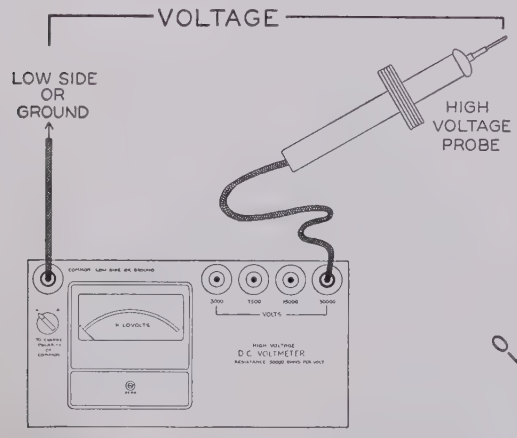
IF DIAMOND PIVOTS ARE DESIRED
ADD $30.00 TO LIST PRICE

These DC multirange kilovoltmeters provide a safe and accurate means of making measurements up to 30 KV. The indicator is a University Model .5% accurate microammeter with a 4" hand drawn mirrored scale and a basic sensitivity of 20 microamperes for full scale deflection. The University instrument is connected in series with an internal high voltage multiplier which is molded in a solid block of insulation to reduce corona. The panel of the Model DCHI contains a convenient polarity reversing switch. The range connection plugs are made of polystyrene to increase the effective leakage resistance between the high and low sides. The indicating instrument is in a separate molded bakelite case and is connected to the low side.

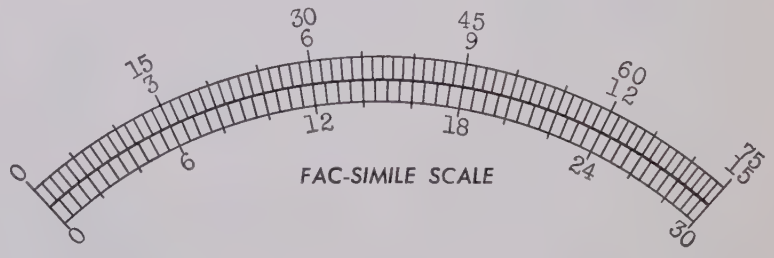


HIGH VOLTAGE PROBE

An insulated high voltage probe is available if desired. This probe is constructed of polystyrene and incorporates an anti-corona ring on its tip. It has a solid polystyrene hand guard and a shielded high voltage cable. A clip connection is also provided in case it is desired to clip the probe to any voltage connection.



INSTRUMENT SET UP
WHEN USED WITH PROBE



Ranges	Sensitivity	Code	Price
0 - 1.5/3/7.5/15 kilovolts	50,000 ohms per volt	VOLTHO	$220.00
0 - 3/7.5/15/30 kilovolts	all ranges	VOLTHI	230.00

(Supplied with two plugs so user can use any length leads desired)

Insulated High Voltage Polystyrene Probe (optional) $50.00

Because of space limitations in the instrument case, the Model DCHI is not suitable for continuous use at 25 kv. or higher. At these voltages, a maximum duty cycle of not more than 15 minutes in an hour is recommended.

MODEL **N**

The Model N comprises a new series of portable direct current microammeters, milliammeters, ammeters, millivoltmeters, and voltmeters. It features a well shielded, large "U" shaped magnet, (not the common center core type usually found in instruments in its price range) and therefore an inherently high torque to weight ratio; excellent stability and good sensitivity. It's long 6.1 inch hand drawn mirrored scale provides exceptional resolution. The moving element is located in a compartment that is isolated from the main network of wiring and resistors. The instrument can therefore be serviced without unnecessarily exposing this critical mechanism to contamination in the atmosphere.

SPECIFICATIONS

HORIZONTAL USE ONLY

ACCURACY	.5 of 1%
SCALE LENGTH	6. 1"
SCALE DIVISIONS	100 & 150
PERIOD	2 seconds
TYPE	D'Arsonval Double Pivot
PIVOTS	Polished Steel
JEWELS	Sapphire
SHIELDING	Magnetic & Electrostatic
CASE	Moulded Bakelite
SIZE	7½" x 6¾" x 3½"
INST. WEIGHT	8 pounds
SHIP. WEIGHT	11 pounds

IF DIAMOND PIVOTS ARE REQUIRED
ADD $30.00 TO LIST PRICE

The Model N is normally furnished with all ranges brought out to binding posts. However, multirange instruments (excepting most ammeters) are available switch controlled to maximum values of two amperes and 1000 volts. There is a charge of $10.00 for the addition of a range selector switch. "Zero Center" instruments are available at no additional charge.

D C MICROAMMETERS

Full Scale Microamperes	Approx. Res. Ohms	Code Word	Price
50	3000	NICAMS	$131.00
100	950	NICENT	131.00
200	900	NICIPO	131.00
500	450	NICOLA	131.00
50/500/5000	1500/1500/150	NICUXE	$151.00
50/100/200/500/1000	1500/7000/3100/1500/750	NICYUM	171.00
75/150/300/750/1500	1200/2500/2200/ 900/450	NICERO	171.00

ANY single range Microammeter from 50 microamperes, Price $131.00

D C MILLIAMMETERS

Full Scale Milliamperes	Approx. Res. Ohms	Code Word	Price
1	90	NILABI	$125.00
10	20	NILOFS	125.00
50	2	NILOOM	125.00
100	1	NILOUT	125.00
500	.15	NILAAM	125.00

ANY single range Milliammeter from 1 milliampere, Price $125.00

Full Scale Milliamperes	Code Word	Price
.1/1/10	NILEBT	$147.00
1/5/20	NILICA	147.00
1.5/7.5/30	NILODD	141.00
3/15/75	NILUEF	141.00
15/150/1500	NILIMO	141.00
30/300/3000	NILONI	141.00
75/150/300	NILUTH	141.00
1/10/100/1000	NILEGT	149.00
1/2/5/10/20	NILAFS	157.00
1.5/3/7.5/15/30	NILIJU	157.00
5/10/20/50/100	NILUKL	157.00
10/50/100/500/1000	NILELY	157.00
20/50/100/200/500	NILOIV	157.00
75/150/300/750/1500	NILARZ	157.00

D C AMMETERS

Full Scale Amperes	Code Word	Price
1	NAMETI	$129.00
5	NAMOXI	129.00
10	NAMUZV	129.00
50	NAMOFI	133.00

ANY single range Ammeter from 1 to 10 amperes, Price $129.00
up to 50 amperes, Price $133.00

Full Scale Amperes	Code Word	Price
.05/.5/5	NAMMUK	$143.00
.1/1/10	NAMMAC	143.00
.5/1/2	NAMMAH	143.00
1/2/5	NAMMEN	143.00
1.5/3/15	NAMNIF	143.00
3/15/30	NAMMUJ	143.00
5/10/20	NAMMIZ	143.00
10/20/50	NAMMOI	143.00
1.5/3/7.5/15	NAMMRE	158.00
1/2/5/10/20	NAMMOY	173.00

All Ammeters supplied with Binding Posts only. Shunts are self contained.

D C MILLIVOLTMETERS

(Sensitivity 1000 ohms/volt)

Full Scale Millivolts	Code Word	Price
50	NIMIVA	$131.00

ANY single range Millivoltmeter from 20 millivolts, Price $131.00.

All Millivoltmeters supplied with 5' .026 ohm leads calibrated with the instrument. For use with external heavy current shunts.

Full Scale Millivolts	Code Word	Price
50/100	NIMIVOL	$146.00
20/50/100	NIMIVAK	154.00
20/50/100/200/500	NIMIVEL	169.00
20/50/200/500/2000	NIMIVUP	169.00

Above millivoltmeters normally supplied with a 100 division scale labeled "Millivolts." A 150 division scale and/or the legend "Amperes" can be substituted at no extra charge. A double scale can be drawn at an additional cost of $15.00. The scale plate can have a maximum of 4 rows of numerals. Each set of divisions is normally furnished with a single row of printed numerals. Additional rows are $5.00 each.

D C VOLTMETERS

(Sensitivity 1000 ohms/volt)

Full Scale Volts	Code Word	Price
1.5	NIVOLT	$128.00
150	NIVOCU	128.00
750	NIVOSH	135.00
1000	NIVOTZ	135.00

ANY single range from 1 v to 500 v, Price $128.00; over 500 v to 1000 v, Price $135.00.

Full Scale Volts	Code Word	Price
3/15/150	NIVOHO	$142.00
5/50/500	NIVOUX	142.00
150/300/750	NIVORG	152.00
200/500/1000	NIVOPI	152.00
7.5/15/30/75	NIVOLK	152.00
75/150/300/750	NIVONS	162.00
3/15/75/300/1500	NIVOVE	183.00
50/100/200/500/1000	NIVOWL	178.00

DC Voltmeters also available with a sensitivity of 5000 ohms/volt. Add $10.00 to list price and if a catalog range, specify by adding "S" to the proper code word.

1500 v range cannot be switch controlled.

Note: It is impossible to list all combinations of volt ranges because of space limitations. The following information is pertinent to the selection of special volt ranges.

A. Any single range from 1 v to 500 v, Price $128.00
Any single range over 500 v to 1000 v, Price $135.00

B. Any triple range (requiring 1 set of scale divisions) from 1 v to 500 v, Price $142.00; over 500 v to 1000 v, Price $152.00

C. Any four range (requiring 1 set of scale divisions) from 1 v to 500 v, Price$152.00; over 500 v to 1000 v, Price $162.00

D. Add $10.00 to price in "A," "B." "C" if sensitivity 5000 ohms/volt

E. If special ranges requested need an additional set of scale divisions for good readability, add $15.00.

MODEL NPR

Accuracy .5% of full scale

Scale length 6.1"

D C VOLT - MILLIAMMETER

The Model NPR comprises a series of Polyrangers that can be furnished for either portable use or panel mounting. It must be specified whether these instruments are to be calibrated in a horizontal or vertical position.

The Model NPR is normally furnished with a range changing selector switch mounted on its front panel. If desired, when panel mounting is specified, it can be supplied with all ranges brought out to a terminal strip on the back of the case.

The voltage and current circuits are electrically isolated. In almost all respects, including dimensionally, the Model NPR is an exact duplicate of the Models N and NP. (Mounting dimensions are listed on page 227.)

The portable type only is available with Diamond Pivots at an additional cost of $30.00.

.2/2/20/200/2000 MA.
2/20/200/500 Volts — NPRAIL — $255.00
(1000 ohms per volt)

1/5/10/100/500 MA.
5/10/50/100/500 Volts — NPROST — $240.00
(1000 ohms per volt)

5/10/50/100/500/1000 MA.
5/10/50/100/500 volts — NPREEL — $255.00
(1000 ohms per volt)

3/7.5/15/30/75/150 MA.
7.5/15/30/75/150/300 Volts — NPRUSK — $255.00
(1000 ohms per volt)

MODEL NP

See page 227 for NP mounting dimensions.

The Model NP comprises a new series of rectangular DC microammeters, milliammeters, ammeters, millivoltmeters and voltmeters for vertical panel mounting. It is identical to the Model N described on page 229 except it is not offered in all the same sensitivities and ranges.

The Model NP is normally furnished with all ranges brought out to terminals. However, multirange instruments (excepting ammeters) are available switch controlled to maximum values of 2 amperes and 1000 volts. There is a charge of $10.00 for the addition of a range selector switch.

"Zero Center" instruments are available at no additional charge. Internal illumination can be supplied at a surcharge of $24.00. The Model NP is not available Diamond Pivoted.

D C MICROAMMETERS

Full Scale Microamperes	Approx. Resist. Ohms	Code Word	Price
200	5400	NPICOS	$131.00
300	2800	NPICAB	131.00
500	700	NPICUL	131.00
750	200	NPICER	131.00

ANY single range Microammeter from 200 microamperes, Price $131.00.

Full Scale Microamperes	Approx. Resist. Ohms	Code Word	Price
200/500/1000	6000/13000/9000	NPICOO	$151.00
300/750/1500	3000/6500/4000	NPICUL	151.00
500/1000/2000	700/2000/500	NPICRY	151.00
200/500/1000/2000/5000	6000/13000/9000/5000/2000	NPICCE	171.00
300/750/1500/3000/7500	3000/6500/4000/2500/1000	NPICTA	171.00

D C MILLIAMMETERS

Full Scale Milliamperes	Approx. Resist. Ohms	Code Word	Price
1	175	NPILOK	$125.00
10	5	NPILIK	125.00
50	7	NPILAP	125.00
100	6	NPIL00	125.00
500	1.5	NPILIM	125.00

ANY single range Milliammeter from 1 milliampere, Price $125.00

D C MILLIAMMETERS (cont.)

Full Scale Milliamperes	Code Word	Price
1.5/3/15	NPILLY	$141.00
3/15/30	NPILAB	141.00
5/20/100	NPILTY	141.00
7.5/30/75	NPILEC	141.00
10/100/1000	NPILAZ	141.00
15/150/1500	NPILTH	141.00
30/75/150	NPILRE	141.00
75/150/300	NPILUJ	141.00
100/200/500	NPILYM	141.00
300/750/1500	NPILNA	141.00
1.5/3/7.5/15/30	NPILST	157.00
1.5/7.5/30/150/750	NPILBY	157.00
1/5/10/20/50	NPILVO	157.00
3/15/75/300/1500	NPILCA	157.00
5/20/100/500/1000	NPILJI	157.00
75/150/300/750/1500	NPILDJ	157.00
100/200/500/1000/2000	NPILGS	157.00

D C AMMETERS

Full Scale Amperes	Code Word	Price
1	NPAMOL	$129.00
10	NPAMID	129.00
30	NPAMYI	133.00

ANY single range ammeter from 1 to 10 amperes, Price $129.00; up to 30 amperes, Price $133.00. All ammeters supplied with terminals only. Shunts are self-contained.

Full Scale Amperes	Code Word	Price
.5/1/2	NPAMAZ	$143.00
1/5/10	NPAMRY	143.00
1.5/3/7.5	NPAMEP	143.00
2/10/20	NPAMIF	143.00
3/15/30	NPAMOJ	143.00
.75/1.5/3/7.5/15	NPAMUN	173.00
1/2/5/10/20	NPAMBO	173.00

D C MILLIVOLTMETERS

(Sensitivity 1000 ohms/volt)

Full Scale Millivolts	Code Word	Price
50	NPMILO	$131.00
100	NPMITA	131.00

Supplied and calibrated with 5' .026 ohm leads. For use with external heavy current shunts. See shunt section. Normally furnished with a 100 division scale labeled "Millivolts." A 150 division scale and/or legend "Amperes" can be substituted at no extra charge. A dual scale can be drawn at an additional cost of $15.00. Scale plate can have a maximum of 4 rows of numerals. Each set of divisions normally furnished with a single row of printed numerals. Additional rows are $5.00 each.

D C VOLTMETERS

(Sensitivity 1000 ohms/volt)

All ranges and price information the same as for the Model N listed on page 230. When specifying for panel mounting identify as the Model NP and add the suffix "-P" to the code word designating the ranges desired.

Lowest full scale value for 5000 ohms/volt instrument is 1.5 volts. Listed below are some additional 5 range combinations:

Full Scale Volts	Code Word	Price
1.5/3/7.5/30/75	NPVORT	$162.00
30/75/150/300/750	NPVOLD	162.00
5/10/50/100/500	NPVAME	183.00
75/150/300/750/1500	NPVOLI	178.00

Above Voltmeters available at a sensitivity of 5000 ohms/volt. Add $10.00 to list price. Specify by adding the letter "S" to the code word.

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